The congested traffic at all times interfered with the operations and made it especially difficult to set out and take up the drag, which had to be done every time a shoal was found. During the dragging the guiding launch kept as nearly as practicable to a prearranged line, while the end launch kept a tension on the wire by heading at nearly right angles to the direction of progress. Nearly all of the forward motion of the drag was due to the currents. Ranges were used, and no attempt was made while dragging to plot the observations, which were taken at frequent intervals. This is reflected in Fig. 2.

The operation may be described as the development, by means of a wire under tension, of a horizontal plane at a fixed depth below a datum plane (in this case mean low water). The aim in channel work is to keep the planes as near to a predetermined depth as practicable and, when projections above them are found, to prove the surrounding depths correct, as well as those on the projections. This was not entirely practicable in the East River, but the value of the practice is evident when it is realized that the discovery of these shoals makes their removal necessary.

By comparing the depth found on shoals with the depth of the wire that first found them, the amount of projection can be seen. In some cases the previously charted depth was much greater than the depth of the drag wire, the extreme difference being 22 ft.

The summary of results to Dec. 31, 1915, from the beginning of wire-drag work in 1904 follows:

	Sq.Mi. Dragged	No. of Shoals Found
Atlantic Coast and Porto Rico	1,188	2,819
Pacific Coast, including Panama and Alaska	812	373
Total	2,000	3,192

The plans for next season's work on the Atlantic Coast include the completion of the doubtful area between Nahant and Cape Ann and between Plymouth and the Cape Cod Canal entrance; in western Long Island Sound, continuing the work done in the East River. In Alaska the dragging of the main channels of southeastern Alaska will be continued.

Discussion of Conductor Heads for Roof Drainage

By Albert M. Wolf*

One sees very few sets of building plans that contain details of the heads for rainwater conductors provided to carry off the roof drainage. In general, conductor-head details are covered entirely by the specifications and a short note on the roof plan, somewhat like this, "Provide heavy copper or cast-iron strainer at all downspouts." The specifications merely state that all conductor heads are to be formed of a copper pan or funnel flashed into the end of the conductor and the open end of the pipe protected by a copper screen or a galvanized-wire strainer.

In some cases, where a conscientious roofer has the job, a good conductor head will be constructed even under such a loose specification as the foregoing, while in others more often just the opposite may be true. It may seem to some that this is a trivial matter in the construction of a building, but in the writer's opinion it deserves much more attention than it usually receives. Instances have occurred where the downspouts provided for roof drainage have seemed inadequate when, as a matter of fact, the conductor-head construction was of such a flimsy character and so poorly arranged as to shut off the conductor almost entirely through accumulations of gravel, leaves, dirt, etc. Then again some consideration as to the type and pitch of the roof should be given when detailing the conductor head and fixing the size of the conductor. It is apparent that the same conductor-head detail and the same size of conductor should not be used for equal areas of flat and pitched roof, yet we quite often see downspout details for saw-tooth roof construction which are wholly inadequate, since they were originally developed for flat, or nearly flat, roofs.

The common practice in determining the proper size of downspout is to provide 1 sq.in. of conductor area for each 100 sq.ft. of area of what are commonly known as flat roofs (slope $\frac{1}{4}$ in. to $\frac{3}{4}$ in. per ft.) in the Central States and 1 sq.in. of conductor for each 75 sq.ft. in localities where the rains are more severe. For roofs of greater pitch the areas to be cared for by 1 sq.in. of conductor should be decreased in the following ratios: 15% for $\frac{1}{2}$ pitch and 25% for $\frac{3}{4}$ pitch. In no case should a downspout be less than 2 in. in diameter and preferably not less than 4 in.

The conductor head should be of such size and arrangement as to present about twice or three times as great a width or diameter as the conductor, so that even if a portion of the screen should become clogged or stopped up with débris there will still be sufficient inlet area to carry away the water without flooding the roof.

As previously stated, the downspout arrangements for saw-tooth roofs demand special attention in order that satisfactory results may be obtained. On such roofs it is highly essential that downspouts be placed in each line of valleys and that they be designed to serve a much smaller area than for ordinary roofs of the same pitch. In winter there is always a tendency for snow to drift into the valleys; and in mild weather, when alternate thawing and freezing take place, difficulties of getting the water to the conductors are sure to be experienced unless they are spaced fairly close together and the screens or strainers carried up some distance above the roof line.

Wherever practicable, the downspouts should be placed on the inside of the building, to prevent freezing and bursting in winter. It will be found that wrought-iron pipe gives better satisfaction for interior conductors than cast-iron pipe, since it can be obtained in longer lengths, is not as heavy, requires no calking (threaded sleeve connections being made between sections) and does not take up as much space as hub and spigot cast-iron pipe.

Discussion of Different Types of Conductor Head

Type 1—Probably the most common type of conductor head is that given in the drawing as type 1; and when no other detail is shown on the plans, this represents fairly well what the owner gets. From the figure it can be seen that this conductor head consists primarily of a balloon-shaped galvanized- or copper-wire strainer soldered to the copper sump box of funnel shape, which is in turn soldered to the downspout connection pipe.

This construction is about the cheapest one that affords a guard against gravel, leaves, paper, etc., going down the conductor. Quite naturally it is not very permanent or strong and is subject to the danger of being easily misplaced or broken down. For this reason it should be used

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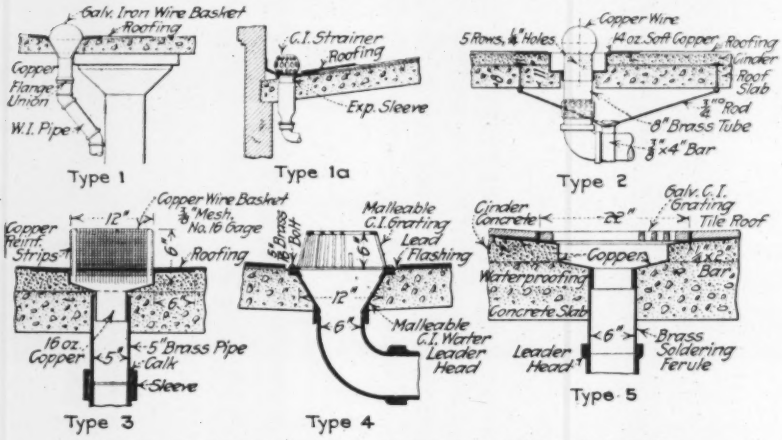
only on the cheaper class of buildings and those of a more or less temporary character. For large buildings of steel and concrete construction some one of the more permanent types should be used.

As a general rule the exposed area of the wire strainer is not large enough to allow sufficient water to enter the conductor so that it will work at anywhere near its normal capacity. The screen not being made as large as the sump box, the latter soon becomes filled with gravel, cinders and dirt, still further reducing the capacity of the downspout. Frequent inspection is therefore necessary, but this is very seldom given unless the roof is used for some purpose or other, such as a playground, testing-ground or roof-garden, in which case a conductor head of this style is entirely out of place, types 4 and 5 being the logical ones to use. These latter, being very strong, eliminate any danger of injuries due to stepping into downspout sumps, while the opposite is true of type 1, which is at best a flimsy protection.



CROSS-SECTIONS OF FIVE TYPES OF CONDUCTOR HEAD

Standard cast-iron downspout heads of the form shown in type 1-A are often used for small-sized conductors. The disadvantages of this kind of strainer are the same as those just cited. They are, however, much more stable and permanent than wire baskets. The prime disadvantage is that the openings in the strainer are not sufficient for the size of the pipe to which they are attached; and if conductors are not considerably oversize, flooding of the roof may take place during heavy storms.

Type 2—A modification of the type 1 conductor head is shown as type 2. In this head a copper-ball wire strainer is soldered to a copper ring punched with ¼-in. diameter holes near the top and is set in a square copper sump box of slightly larger size than the strainer, the whole being soldered to a brass tube threaded into the downspout.

This form of leader head is a considerable improvement over type 1, but nevertheless it possesses some of the latter's disadvantages. The exposed area of the strainer is not enough larger than the conductor to allow it to operate at full capacity. The screen not being made as large as the sump box, the latter soon becomes filled with a mixture of gravel (from roofing), cinders, dirt, leaves, etc., that still further reduces the capacity of the intake. By sloping the sides of the sump box slightly, as in type 3, the dirt will tend to wash down the conductor instead of lodging in the box, but accumulations around the head can be prevented only by using a large guard over the downspout, as in type 3.

Type 3—The conductor-head detail designated as type 3 might be called another modification of type 1. This head consists of a square basket of No. 16 copper wire of ¾-in. mesh soldered to the sump box, with sloping bottom formed of 16-oz. cold-rolled copper, with a tube at the bottom fitted into and soldered to a brass soldering ferrule. This ferrule is then calked into the wrought-iron or cast-iron conductor pipe.

The wire basket should project above the roof a height about equal to the diameter of the conductor, and the corners should be reinforced with strips of copper to give greater rigidity. By making the basket about twice as large as the conductor pipe the danger of the screens becoming stopped up is reduced to a minimum and flooding of the roof is avoided.

For buildings of permanent construction where the roof is little used or inspected, this conductor will give good service. It is adapted for comparatively flat roofs or those with considerable pitch, and viewed from the standpoint of simplicity and ease of erection, it merits extensive installation, except on buildings where the roof serves various purposes.

Type 4—A conductor head of very nearly permanent character is shown as type 4. It is applied to a concrete roof with a fairly flat slope formed by pitching the slab itself and not by cinder saddles. The head consists of a malleable cast-iron grating of about twice the diameter of the conductor projecting above the roof line a distance equal to the diameter of the downspout. Brass bolts connect the conductor head to a funnel-shaped malleable cast-iron water-leader head.

This conductor head is of excellent design, since it has a very strong grating with a large portion of its surface open for the passage of water and is rigidly connected to the funnel-shaped leader head, thus preventing the accumulation of dirt in or around the head. It is particularly suitable for large concrete buildings where the roof is subjected to more or less use, such service necessitating a conductor head that cannot easily be broken down.

A Flush Grating for Utilized Roofs

Type 5—The utilization of the roofs of buildings as playgrounds, roof-gardens, automobile testing-grounds, etc., has greatly increased in the past few years. For such roofs it is highly essential to provide a conductor head of such construction as not to obstruct the roof surface. In type 5 is shown a conductor head of this kind, which has been placed with good results on a large number of concrete buildings the roofs of which are covered with promenade tile.

The head consists of a flat square cast-iron bar grating set over a copper sump box, with sloping bottom and circular outlet, soldered to a brass soldering ferrule that is calked into the conductor pipe. To prevent water from backing up under the tile covering the copper sides of the sump box flashed thereunder, the copper is carried up over a steel bar set alongside the grating and flush with it.

It will be noticed that the openings in the grating are quite large, in fact much larger than those in any of the other styles. This is because it was designed for use on promenade-tile roofs rather than for a roof with tar and gravel covering, the gravel from which might soon clog the grating. The one objection to this style of roof sump is that it can be practically stopped up by papers, etc., owing to its being perfectly flat. Where such sumps are used, however, at least a few persons are on the roof each day and the chance of a downspout being left in a plugged condition so as to flood the roof is rather remote.

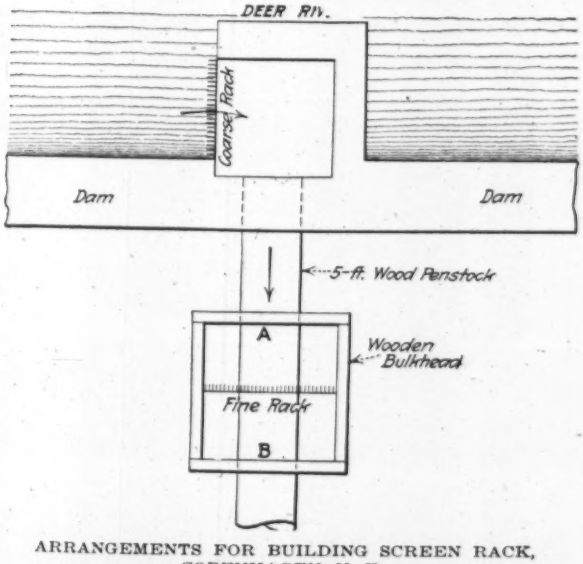
For permanent buildings of good construction only the last three types can be recommended as being consistent with good building practice. Although they cost considerably more than the others described, their installation is money well spent.

Ice Pipe Carries Power Water While Screen Is Installed

A fine-screen rack was built this winter in the wooden penstock line of the Deer River Power Co. at Copenhagen, N. Y., and it was found possible to facilitate the work without interrupting service by the unusual expedient of using an ice lining to carry the water. Water is conveyed to a power plant through a penstock consisting of a wood-stave pipe 5 ft. in diameter. The head is 175 ft., but the upper portion of the penstock is not under pressure. A wooden bulkhead (see illustration) was built around the penstock just below the intake. It was proposed, in order to install the fine rack, to shut down the plant for a couple of days while a section *AB* of the wooden pipe was cut out and the screen was being placed in position.

On cutting the staves of the wooden pipe it was found that there was a 9-in. layer of hard ice inside the pipe. Accordingly, care was taken not to disturb this ice pipe while the remaining staves were cut away. Holes were bored through the ice, and through them the 3x¼-in. trash-rack bars were inserted in place.

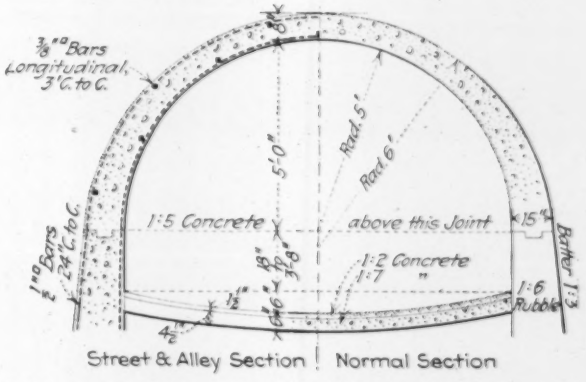
Using the natural ice sluice in this way, it was possible to work practically dry within the bulkhead while securing the rack bars in position. The job was completed with water flowing through the ice pipe and filling it half full, thus providing for the power requirements and avoiding a shutdown of the plant.



ARRANGEMENTS FOR BUILDING SCREEN RACK, COPENHAGEN, N. Y.
Ice pipe left between A and B after removal of wood penstock

Scarcity of Steel Results in Plain Concrete for Sewers

The high price and slow delivery of steel are driving engineers to various expedients of construction to eliminate all the steel possible from their structures. In Austin, Tex., the city engineer, M. C. Welborn, has under way about $50,000 worth of storm sewers and the replacing of a number of bridges washed out during the floods of 1915. Several of these structures have been redesigned as plain concrete arches, the additional concrete being cheaper than reinforcing steel at the prevailing prices. Moreover, 100 tons of steel ordered



CROSS-SECTION OF ARCH STORM SEWERS, AUSTIN, TEX.

by the city last summer had not been delivered by Mar. 1, 1916.

Storm sewers of 8-, 9- and 10-ft. semicircular arches are being constructed of plain concrete, to the cross-section shown herewith. These sewers are under the sidewalk areas (sidewalk or parking), where they will carry no heavy street loads except at street and alley intersections. Here the reinforcement shown in the left-hand part of the cross-section is used.

In these reinforced portions all arch rods extend 3 ft. below the springing line of the arch.

The arch concrete is mixed 1:5 and the arch abutments 1:6. Rubble stone is used wherever the size of the member is sufficient. The 6-in. invert is made in two courses. The bottom course is 4½ in. of 1:7 concrete, and the top course is 1½ in. of 1:2 concrete for resistance to abrasion.

For small sewers, concrete pipe is used in Austin. This is unreinforced. A city plant for making the pipe has been in operation several years, and the results are quite satisfactory.

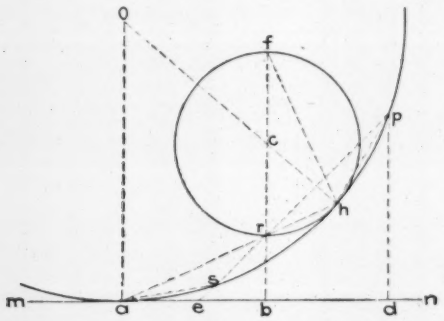
A natural gravel aggregate obtained from the Colorado River bed is used.

Locomotive Crane with Generator-Car Trailers is a novel arrangement devised by necessity. Some time ago the Pennsylvania Railroad Co. bought four 30-ton locomotive cranes from the Ohio Locomotive Crane Co. (Bucyrus, Ohio). Recently it was desired to equip two of these cranes with lifting magnets, but there was no room on the crane car for the necessary electric generator. Consequently a small flat trailer was built and a generator set installed on board. Both of these cranes are now in service.

NOTES

An Infiltration Gallery for the water-supply of Lockhart, Tex., is being developed by Henry E. Elrod, consulting engineer, Dallas, Tex. The city is situated on a bed of gumbo soil about 10 ft. deep which overlies a saturated bed of sand and gravel. To tap the groundwater, a trench 10 ft. wide, 140 ft. long and 25 to 30 ft. deep is excavated. The sides of the trench are supported by concrete walls, and the bottom is left open. The water thus intercepted will flow to a sump at one end of the trench and be pumped thence to the city mains.

A Railroad Turnout Problem; Geometrical Solution—A problem that is not uncommon in detail location of railway tracks is treated by C. G. Edwards, Southern Pacific Co., San Francisco, Calif., by the following interesting method. The problem was to run in a curve from a given tangent to pass through a given point and to pass at a prescribed distance from the corner of a building. The point and the corner of the building are supposed to be tied in to the tangent. In

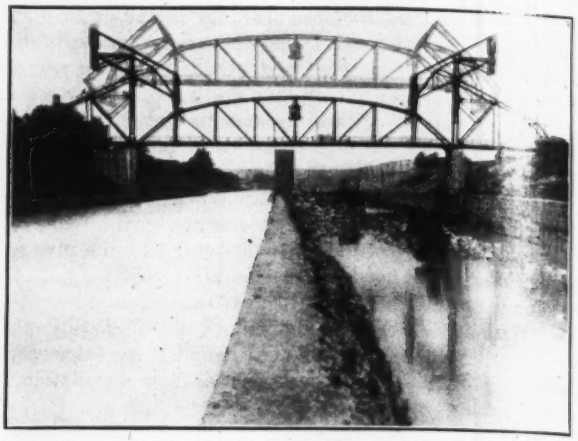


TURNOUT PROBLEM, GEOMETRICAL SOLUTION

the sketch mn is the given tangent, p the given point and c the corner of the building. A circle rhf is drawn around c with the prescribed clearance distance ch as radius. The required turnout is represented by the curve shp with center at o. Joint a and h. This line intersects the small circle at r, which is in the vertical line below c, as can readily be shown by similarity of the triangles chr and oha. Draw other construction lines as shown. The triangles asr and phr are similar, which gives the equation $sr \times rp = rh \times ar$. Also the triangles abr and rhf are similar, which gives the equation $rh \times ra = rb \times rf$, substituting which gives $sr \times rp = rb \times rf$. In this equation all quantities except sr can be calculated from the known positions of points c and p with respect to the line mn. Then sr is computed, and from it se and sp can be found. As ae is a mean proportional between se and sp, the beginning of the curve is fixed. It is then a simple matter to find the radius.

Adding Machines used in Field by Leveling Parties—The precise-leveling parties in charge of J. H. Peters and G. D. Cowie of the United States Coast and Geodetic Survey, operating in Indiana and Florida, respectively, are recording the readings of the level rods on adding machines as the work progresses. The machine is strapped to the top of a motor velocipede on which the party goes to and from the working ground. The leveling is done along railroads, and the car is moved forward with the observer as the work progresses. The adding machines are now being used in the field for the first time in such work. From the results up to now it is concluded that recording can be done more quickly and with less likelihood of errors than when the recorder uses the old method of entering the observations in a record book. Backsights and foresights are recorded in separate columns, whose sums may be obtained by pulling a lever. The difference between these two sums is the difference in elevation between the starting and ending benchmarks of the line. The machine is of the listing type, so that it gives a permanent record of the observations on the reel of paper. The saving of time and money in a single season will much more than pay for the cost of the machine in the opinion of officials of the Survey.

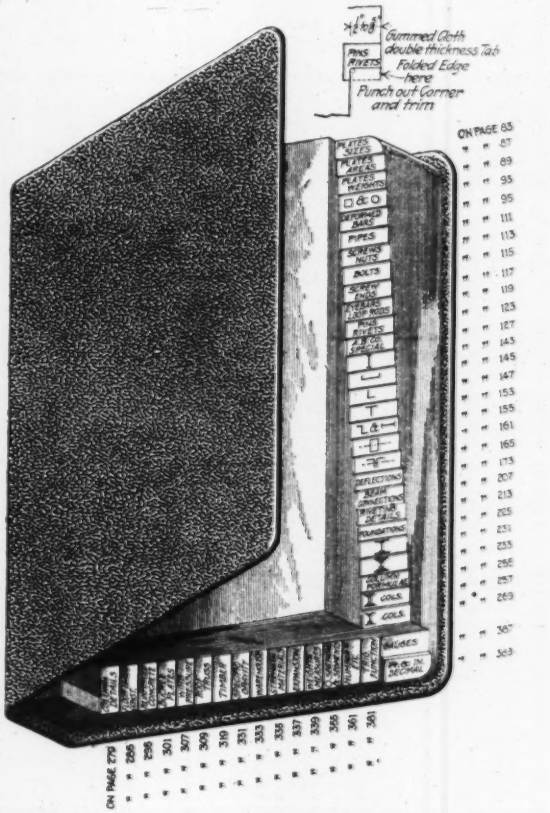
Moving Picture of a Lift Bridge—The Strauss direct-lift bridge over the Louisville & Portland Canal, near lock and dam No. 41, Ohio River, at Louisville, is shown in an interesting manner in the photograph. Both positions of the bridge are shown by clever superposition of the photographic printing. Five bridges of this type have been built up to



"MOVING PICTURE" OF LIFT BRIDGE OVER LOUISVILLE & PORTLAND CANAL

the present, the earliest in 1910. The Louisville bridge is the most recent. Its completion was noted in "Engineering News" of July 15, 1915, p. 123. It spans 210 ft. in the clear. The lift is 40 ft. and gives 90-ft. clearance above normal stage.

Index for Steel Handbook—Herewith is a sketch of a convenient thumb index for the Carnegie handbook. This index is in use at the county engineer's office in Pittsburgh, and it was worked up by A. D. Nutter, structural engineer in that office. Others might find another index more suited to their work, but the mechanical make-up would be the same. About



THUMB INDEX FOR CARNEGIE POCKET COMPANION (1913 EDITION)

45 headings can be placed on a page of the handbook. Although the 1913 edition is more complete than the old one, yet many readers have found considerable trouble in locating information, and the difficulty is increased by the thin paper used. The tabs are a considerable help in consulting the handbook.

Editorials

Reviving the Natural-Cement Industry in America

Attention was called in these columns two years ago to the importance of preserving the natural-cement industry, which has been steadily declining during the past fifteen years until the output of natural cement has fallen considerably below a million barrels per annum.

In view of the high prices now prevailing for portland cement, the present is a particularly favorable time for renewed activity in the natural-cement industry. It is of interest to observe that one large producer of natural cement in the Middle West has undertaken an active campaign to reëstablish natural cement in the favor of engineers. There is no doubt that one reason why portland cement has so largely crowded out its old competitor is the extent to which it has been advertised as a superior material.

That portland cement is superior for many uses is beyond question; but as was pointed out in these columns two years ago, the older generation of engineers, at least, is aware that natural cement possesses qualities that make its use advantageous in certain places. The buttery consistency of mortar made from natural cement makes it valuable in laying brick and stone masonry. Its slow-setting quality, while on many works a drawback, is in other places an important advantage.

In laying street-pavement foundations, for example, it is now the universal practice to haul the sand and stone and dump it in the street, from which it is shoveled, with more or less street dirt, onto the mixing platform or into the mixer. By the use of a slow-setting cement, however, it would be possible to establish semi-permanent concrete-mixing plants, where the material would be discharged from bins directly into the mixer and the mixed concrete would be hauled in tight dump-carts from this mixing plant to the place where the concrete is to be used.

The durability and reliability of natural cement are attested by the condition of most of the older engineering works in this country built prior to 1880. It is the general experience that where natural cement was used for foundations the work is generally in perfect condition, while works in natural cement exposed to weather and frost action show more or less deterioration. Exactly the same thing could be said, however, concerning works which were executed in portland cement and which have not had nearly as long exposure.

It is also a fact that where old structures of natural cement are torn out at the present day a large variation is found. Some of the work is as hard and sound as a good natural stone, while other work crumbles readily and is easily excavated with hand tools. When the conditions are recalled under which natural cement was manufactured and used fifty years or more ago, it is not at all difficult to understand why such variations in condition should occur. Cement manufacturers of that day were working to a large extent in the dark, with rule-of-thumb methods and without the aid of applied chemistry. The engineer who used cement, also, was in many cases ignorant of the care necessary in its mixing and manipulation, to secure reliable results. It ought to be possible with modern methods of manufacture of natural cement and with the same care in its use as is exercised with portland cement to carry out work with natural cement that would be even better than the monumental work done with it two generations ago.

Soft Ground Tunneling

Engineers interested in tunneling work will read with interest the description elsewhere in this issue of the methods adopted at Memphis, Tenn., in driving two soft-ground tunnels as a part of a new storm-water drainage system. Each of these tunnels is nearly half a mile long, and work on each of them was begun with steel shields forced forward by hydraulic jacks.

These shields were of much lighter construction than those which have ordinarily been used for subaqueous tunneling. The shells were a single thickness of 5/8-in. plates, there was no interior diaphragm, and the interior bracing was light. In one of these tunnels the shield was successfully used throughout the work. In the other tunnel, of somewhat larger diameter, the shield failed after the tunnel had been driven a short distance. It was repaired and reinforced at a heavy outlay in time and money, but again broke down and was abandoned, and the remainder of the tunnel was driven by other methods.

It is sometimes a difficult question to decide whether the conditions under which a soft-ground tunnel is to be driven are such as to call for the use of a shield. Of course, where a tunnel is to be driven under a body of water through running ground, shield tunneling is necessary for safety. In most soft-ground tunneling, however, the work can be done, if necessity requires, with ordinary methods of drifting and timbering, supplemented if necessary by the use of compressed air and by the drainage of ground in advance of the tunnel by wells.

Where the use of a shield is decided upon, it should be made strong enough to stand the heavy stresses upon it. A tunnel shield may have to carry the load of the entire over-burden above the tunnel roof. The jacks that force the tunnel forward may exert a pressure of a thousand tons or more; stones, logs and other obstructions to the shield's cutting edge may tend to distort the shield.

The temptation to economize in shield construction is especially great where the shield is used for a short tunnel. The stresses on the shield, however, may be as great in a short tunnel as in a long one; and if it is worth while to use a shield at all, it is sound economy to make it amply strong for its work.

The Largest Reservoir in North America

The largest reservoir in North America is being created in the Province of Quebec. It will store 160 billion cubic feet of water and allow the regulation of the St. Maurice River so that some 168,000 hp. more is available as steady power at three points below. This reservoir is to be compared with the next largest in North America, the Elephant Butte reservoir of the United States Reclamation Service, in New Mexico, having an eventual 115 billion cubic feet of impounded water. The St. Maurice reservoir is exceeded in the list of the world's largest only by Gatun Lake, at Panama (183 billion cubic feet), and the Nile River above Assuan (3,750 billion cubic feet).

This project is of timely interest as the first storage and river-regulation scheme for power to be actually undertaken in America that can approach the description "enormous." The magnitude here is of flooded area and impounded water rather than cost of works, being in the natural-lake region of the St. Maurice headwaters.

The dam for this reservoir, the design and construction of which are set forth elsewhere in this issue, is not an unusual structure. The matter that will excite the greatest interest in the dam itself is the selection of the solid-gravity section instead of the hollow-deck design, where the transportation is so peculiarly difficult as at St. Maurice. The reason, it appears from the reports, was the caution which the Streams Commission and its engineers desired to exhibit in this their first great undertaking. Mingled with their caution there seems to have been an underlying feeling that the prestige of a government project and a great artificial lake required the sort of monumental and everlasting structure afforded by solid masonry.

In this particular case the saving of a hollow dam over the solid type is minimized. This structure is a long low structure for the most part, in which the yardage of decks, buttresses and aprons would begin to approach the yardage of a solid dam. Moreover, much of the cost of the work is represented in the cost of providing means of transportation, getting equipment to the site, maintaining the labor force, etc.—all items that would yield no appreciable reduction in the construction of a hollow dam.

Looking at the dam and reservoir from another viewpoint, the advantages of the location are shown in new light. The quantity of concrete needed is 70,000, the reservoir capacity created is 160 billion—a unit figure of 0.44 cu.yd. of concrete per million cubic feet. What this means may be seen by noting the Elephant Butte (solid-gravity section dam) ratio of 4.78 cu.yd. per million cubic feet and the 2.3 figure for the Aziscohos dam (hollow-deck type)—both of which may be taken as the nearest representative cases.

Some question naturally arises as to how the province can afford to go ahead with as large and expensive a project as this while the nation is at war. To see the answer, it is necessary to know something of the unique power situation in the city of Montreal—for current from the most important power developments benefiting from this project (Shawinigan and Grand' Mère) is controlled by the Montreal power utility. There is immediately available for this concern about 123,000 hp. more of steady power than before, and this is worth at least $1,250,000 per year in gross income. The Montreal district is supplied by five large hydro-electric stations with a possible output of some 400,000 hp., and the installed capacity of all these stations is practically loaded its full extent. Such a condition discloses the willingness of private interests to invest money in the improvement of the St. Maurice River.

The reported method of financing the work also is worthy of passing mention, as being affected by the exigencies of the times. The contractor is paid in the Government's bonds, and the benefited interests pay the interest and amortization. But the contractor also represents the power interests, so that, waving legal niceties aside, the benefiting concerns pay the interest on the bonds that they themselves hold. Apparently a desirable end is secured; the Government controls the design, construction and operation, but the entire financial burden is assumed by the power companies. The riparian owners gain by the elimination of intercompany agreements to coöperate in the improvement; arrangements difficult to secure and troublesome to maintain. Apparently each party gets a maximum of what it wants and a minimum of what it naturally would like to escape.

Federal Permits for Water-Power Development

The National Conservation Association at its meeting in Washington last week voted by a large majority to approve the Shields bill, which authorizes the Government to grant fifty-year permits for the development of water power on navigable rivers. Under this bill the development of the power will be under Government supervision, and the rates charged by any company which develops power will be subject to regulation by the authorities of the state in which the plant is located.

The Shields bill has been opposed by Gifford Pinchot and his associates on the ground that it is too generous in its terms to the companies which develop the power and especially that the companies receiving the permits should pay some compensation to the Government in addition to that provided in the bill. Mr. Pinchot's theory is unquestionably sound; but the difficulty lies in its practical application. It sounds reasonable to say that, if the Government is to sell or lease valuable property, it should get the best price the property will bring rather than give it away. But how could a price be fixed which would be fair both to the Government and the people who invest their money in water-power development? It is easy to say that the price should be such as will leave a fair return to the company on its capital invested plus suitable compensation for the risk involved and a reward for the enterprise and industry necessary to organize the corporation and carry the work into effect.

The difficulties of carrying any such ideal plan into effect are insuperable. No engineer or financier is wise enough to predict in advance with any considerable degree of accuracy what will be the annual net earnings (or losses) of a great water-power enterprise five years, ten years or twenty years from the date of its establishment. Unless such an estimate could be made, how would it be possible to appraise the different water-power sites and determine their present-day value or what

would be a fair rate of compensation for their use? It might be possible, of course, to fix by law or executive order a certain rate of compensation for all Federal water-power leases; but under such a plan only the most favorable power sites would be developed and the others would remain idle.

Everyone agrees that it is to the interests of all parties concerned and especially desirable for the conservation of our coal and oil resources that water-power development should again go forward on a large scale. The Government itself obviously cannot go into the business of power development, and it ought therefore to encourage private corporations to carry forward this work and to do so at the earliest possible date.

It is this general view of the matter, we take it, that influenced the National Conservation Association at its recent meeting to reverse its action of three years ago and approve a more liberal policy toward the development of water power.

Road Maintenance Experience in New York State

Engineers interested in highway work will read with interest the paper by T. M. Ripley, one of the Division Engineers of the New York State Highway Department, recounting the experience of that state in road maintenance. It is common enough to hear the blame laid for the unsatisfactory character of New York state roads to the prevalence of graft in the state government, to a defective organization, to corruption in politics, to incompetence of the men who planned and built the roads, to mistakes in the selection of the type of road to be built. Each and all of these assigned causes have had something to do in producing that result, but the most important cause of all, well set forth by Mr. Ripley in his paper in this issue, is the rapid and revolutionary series of changes in the traffic upon these roads. No one could foresee these changes fifteen years ago or ten years or even five years ago, and the changes which are even now going on have a very important bearing on the type of road that should be constructed in future and the methods which should be adopted for its maintenance.

We may refer specifically to the concluding paragraph of Mr. Ripley's statement, in which he calls attention to the terrific damage which is being done to macadam roads, both waterbound and bituminous, by the rapidly increasing traffic of motor omnibuses and motor trucks. It is only within the last two or three years that these vehicles have become an important factor in state highway traffic. The reason why they have so serious an effect on such roads is that they are operated in early spring and late fall when the roads are soft and easily cut up, whereas the touring car traffic which up to three years ago was the main traffic that gave the highway engineer concern did not become important on country roads until after the roads had dried out and settled in the spring. It is stated that in Massachusetts it will require hundreds of thousands of dollars to make good the damage done to the state highways within the past few weeks by heavy motor trucks and motor omnibuses, run over the roads just as the frost is coming out of the ground.

The problem highway engineers must face is the question how to maintain the roads under these conditions. It is evident from Mr. Ripley's review that the enormous cost of maintenance of New York state highways is due not alone to such extraordinary damage but to the unsystematic manner in which the work of maintenance has been carried on, up to two or three years ago.

It is of course an old story that the way to economically maintain a road surface is to take the "stitch in time that saves nine," and to keep the road continuously in good condition; but the advent of the automobile has accentuated the conditions that formerly prevailed, and made prompt and thorough maintenance absolutely essential, not merely to keep a road in good condition but to save it from being entirely destroyed.

It may be of interest in this connection to give some figures as to what New York has actually spent for the maintenance of some of its state roads, built within the last ten years. The Little Falls road in Herkimer County, 5⅓ mi. long, was built in 1906. The total cost, including grading, was $11,165 per mi., and during the six years from 1909 to 1914 inclusive, $7,294 per mi. was spent on it for maintenance and repairs. It is of interest to note that $4,940 per mi. was spent on this road in 1912, probably for the entire reconstruction of the surface. In 1913, however, $269 per mi. was spent upon it, and $562 in 1914. The New Lebanon-Brainard Road in Columbia County was built in 1907. Its length was 8 mi. and the cost of construction was $6,824 per mi. During the six years from 1909 to 1914, $3,928 per mi. was spent on it for maintenance and repairs, $1,702 per mi. was spent in 1913.

The Canton-Ogdensburg road in St. Lawrence County, built in 1908, is 7.9 mi. long, and cost $8,595 per mi. In the six years following, $3,270 per mi. was spent for maintenance and repairs. A road subjected to heavy travel between Troy and Schenectady, 3 mi. long, was built in 1907, at a cost of $11,782 per mi. In the six years from 1909 to 1914 $10,376 per mi. was spent on it for maintenance and repairs, of which $5,654 per mi. was spent in 1912, and over $1,000 per mi. in each of the two following years.

It is obvious that if any considerable part of the New York state highway system were to require a permanent annual charge per mile for maintenance such as these figures indicate, the burden on the taxpayers would be insupportable. As Mr. Ripley makes clear, however, a considerable part of the high cost of maintenance and repair has been due to the lack of system in maintenance. There are probably a good many miles of the state highway system which will eventually have to be rebuilt from the bottom up with a more permanent foundation to withstand the heavy traffic of the present day, but it is to be hoped that by the introduction of engineering methods in the work of maintenance, most of the roads now built may be kept in condition at a reasonable annual outlay.

That the life of wood-stave pipe depends upon the kind and grade of the wood used for the staves is well brought out by a letter printed elsewhere in this issue. The concluding sentence of the letter will bear repeating: "Fir and pine for strength, redwood for durability, should be as thoroughly understood as steel for strength and cast iron for durability." The letter also relates to the Seattle wood-stave conduits and the arguments recently advanced at Seattle for building a "concrete and steel conduit," besides containing a list of redwood stave-pipe lines installed from 1889 to 1908.

Letters to the Editor

Rating the Qualifications for Success in Engineering

Sir—I see no ground for objecting to the statement of qualities to be looked for in the young engineer as summarized by Prof. C. R. Mann from information received by him in response to an extensive inquiry. These as arranged by him are:

1. Character, integrity, responsibility, resourcefulness, initiative.
2. Judgment, commonsense, scientific attitude, perspective.
3. Efficiency, thoroughness, accuracy, industry.
4. Understanding of men, executive ability.
5. Knowledge of the fundamentals of engineering science.
6. Technique of practice and of business.

It is not so clear that this brief statement can be "used as a standard in developing organizations and curricula and in selecting efficient methods of instruction." There are several reasons for this:

1. The relative value of the several proposed units of measure is not the same; they cannot be marked off as a series of equal units or a single measuring stick, the total length of which will represent the whole man. It cannot be concluded that, because "technique" is sixth, all other qualities combined are five times as important.

2. The measures proposed are not and cannot be independent units; influences that are effective in developing any one cannot fail to produce effects on others. To be serviceable as a measure, the law of dependence should be defined. For example, it is my opinion that in developing technique, character also is developed. To what extent can I depend upon the training in technique as a means of securing character?

3. The school is not equally effective in making its impress upon the several qualities of which the proposed measure is composed. There are in fact some things that a school cannot do. The God-given qualities of a man count tremendously when one attempts to measure him. While we put character first and technique last in importance, when we attempt to measure the man, it would be wrong to assume that character should always be first and technique always last in the amount of attention bestowed by the school. It often happens that students enter school with more character than technique to their credit.

Professor Mann's circular letter is, I assume, to be accepted as an initial proposition, and as such it is extremely interesting. I have no doubt that in time he will disclose the next step in the development of a measure and of means whereby it may be made effective.

Urbana, Ill., Apr. 17, 1916. W. F. M. Goss.

Sir—With reference to the discussion on the qualifications requisite for a successful engineering career, it seems obvious to the writer that the considerations of "character" and "technique" are in nowise comparable, a point that seems to have been disregarded or overlooked in the previous discussion as well as in the preparation of the Mann "score-card." Plainly, if this be the case, two score-cards would be necessary—one for general and one for special qualifications. Under the former would be grouped such qualities as character, judgment and efficiency, giving proper percentage to each so as to make a total of 100%. These are qualities which any business man, be he lawyer, merchant, engineer or what not, would look for in a prospective employee or which would be necessary to a greater or less degree in the successful execution of a business enterprise. On the second score-card would be grouped such other qualities as have a bearing on the special work to be done, as, for an engineer, technical education, experience on similar work, and understanding of men.

A rough analogy may be drawn from the selection of a system of transportation. Suppose a contractor wants to carry a quantity of stone across a body of water. He will not look up the different makes of motor trucks for the simple reason that what he needs is a boat, although a motor truck is a fine transportation machine. Likewise a firm wishing to construct a machine shop will not consult a dentist, although the dentist may have a fine character and good all-round ability.

Furthermore, it seems inadvisable to assign a definite percentage to any one quality, as "efficiency 15%," for so broad a classification as to fit "a successful engineer," since so much depends upon the specific nature of the work to be done. Those qualifications which might make a man a fine bridge designer might not be at all adequate for a superintendent of construction. As a man progresses from one position to another he may make less and less use of his technical knowledge and find his understanding of men and his ability to organize and to hold in mind a general perspective of a large piece of work brought more and more into play.

The obvious conclusion is that no fixed rules can be followed, but that a careful analysis of each case is necessary to bring the right man to the right work.

R. D. Burdick.
Assistant Engineer, N. Y. C. & St. L. R.R.
Cleveland, Ohio, Apr. 24, 1916.

Sir—Referring to your editorial query, "Is Character the Fundamental Requisite for Engineers?" it is hard to understand how any other view could be taken than that character is the foundation stone upon which all the other qualifications must necessarily rest.

It does not matter how bright or how well educated an engineer is or how much past experience he has had, unless he can be trusted absolutely. Unless he is dependable, his other qualifications go for naught. If he is susceptible to dishonesty, he is practically of no value whatever to any client, because he cannot be trusted. "The sharper the blade the keener the cut." I might go on and enlarge along these lines, but I have said enough to have it understood why we must put character as a fundamental requisite for engineers. As to the other requisites, it is my impression that those who made up the list of the Mann "score-cards" had no in-

tention of conveying the impression that technical education should not have the proper consideration. What was in mind in assigning judgment—engineering judgment—was naturally the intention to convey the idea that engineering judgment is not the grocery man's judgment, but is a result of knowledge and experience in engineering. The grocery man who might have excellent judgment in the grocery business might have very poor judgment in the engineering business.

An engineer may be highly educated technically and yet lack the ability to work with men and obtain efficiency. We know of men who have had the greatest advantages technically and ought to rank high in the engineering world, but for the lack of these qualifications under consideration cannot be trusted with important work.

Pasadena, Calif., Apr. 26, 1916. C. W. KOINER.

Sir—Dean Marston's unique use of the Mann "scorecard," as explained by him in your issue of Apr. 20, is peculiarly opportune.

If you grant for the sake of argument, first, that such a use of the card is justifiable and, second, that any significance is to be attached to such ratings of character as 78, 80, 93, etc., by any single observer, however competent, then two interesting questions arise: Is there any connection between the fact that the grocer, the merchant and the banker have a rating on character higher on the average by 5.7 points than that of the engineers and the fact that engineers are seldom chosen as members of public commissions, even when these deal with engineering works? If so, what is the meaning of this to the engineering schools and the engineering profession? W. A. STARRETT.

8 West 40th St., New York City, Apr. 29, 1916.

The Lower Otay Dam Failure

Sir—Your issue of Apr. 13 contains a letter from George Cromwell, City Engineer of San Diego, upon the failure of the Lower Otay dam, in which exception is taken to some remarks from the writer published in *Engineering News* of Mar. 9. Mr. Cromwell attempts to prove that my previous communication was based upon inaccurate data, claiming that all figures were obtained from textbooks, little attention being given to actual conditions.

The height of the dam, 130 ft., is first questioned, the City Engineer stating that the height was 135.5 ft. On p. 31, of the "Transactions" of the American Society of Civil Engineers, Vol. LXXV, the statement is made by Mr. O'Shaughnessy that the Lower Otay dam was completed to the 130-ft. level above the old stream bed on Aug. 18, 1897. Also *Engineering News* of Feb. 3, 1916, gave this dimension as 130 ft. However, in a matter of this kind the City Engineer ought to know, so the error is admitted, attention being called to the fact that the increased height made the structure more unsafe than the writer had previously assumed, and the risks involved in filling the reservoir were therefore greater.

Mr. Cromwell claims that this increased height of dam gave such additional capacity to the spillway that it should be considered in the analysis. The writer's investigation shows that the dam was weaker than the demands of good practice, before the water reached the floor of the spillway, so the capacity of this feature has no bearing whatever on my statement that the basin should not have been allowed to fill.

The slopes of the dam assumed are also questioned. As this matter seemed rather indefinite, computations were made on two slopes—1 : 1 and 1½ : 1. Even with the flatter slope the ratio between resisting force and applied load was much less than the demands of good practice, consequently there appears little meat in Mr. Cromwell's contention that as the slopes were 1¼ : 1, my data were inaccurate. Mr. Cromwell says:

> Third, the investigation relative to the coefficient against sliding, as Mr. Sellew calls it, does not seem to be to the point in view of the fact that the dam did not eventually fail by sliding upon its base.

In the design of dams it is necessary to oppose to the anticipated load a greater force—how much greater will depend upon local conditions and on the type of dam under consideration. With normal conditions a masonry dam will have an opposing force equal to twice the applied load and an earth dam about ten times. A rock-fill should lie between these two. An examination of several rock-fill dams shows the following ratios of the applied load to the opposing force, assuming a full reservoir:

Lower Otay with 1 : 1 slopes	1 : 1.85*
Lower Otay with 1½ : 1 slopes	1 : 2.60
Escondido	1 : 3.25
Castlewood	1 : 2.1
East Cañon Creek	1 : 4.0
Pecos River	1 : 3.35*
Walnut Grove	1 : 2.60*
Morena	1 : 4.90
Stanislau River	1 : 3.20
Bishop Creek	1 : 3.70
South Fork Stanislau River	1 : 5.00

Those marked * have failed. The writer makes no claim that the Lower Otay dam failed by sliding, but presents this table to indicate the relative stability when compared with other structures of its type and submits that the low ratio of the Otay was the source of its weakness, an appreciation of which should have suggested measures to prevent the filling of the reservoir. Mr. Cromwell's contention that the dam failed from overtopping is well answered by the editorial in *Engineering News* of Mar. 9, which shows that the amount of water passing over the top could have had little effect upon a rock-fill.

The City Engineer states that in his opinion the dam would have been standing today had not the water flowed over its top; that is, he believes that a ratio between load and opposing force of 1 : 1.85 is a safe one. It is hard to reconcile this opinion with the fact that after the failure at Otay some two billion gallons were wasted at Morena to lower the high-water line and this structure had a ratio of 1 : 4.90. If the Lower Otay was safe when full, there could be no valid reason for wasting at Morena a volume of water which at 10c. per thousand gallons (the price paid by the city to a private company) was worth $200,000.

A careful review of all the data obtainable convinces the writer that the Lower Otay dam failed because it did not contain sufficient material to resist a pressure due to a full reservoir; that this weakness was apparent from a comparison with other similar dams that had gone out and such weakness should have been known to those in charge of the works. While the dam was unsafe with a full reservoir, it had been of great service to the city when filled to lower levels, and had it been admin-

istered with prudence, San Diego would still be enjoying its benefits.

The discrepancies in design and construction were so apparent that there can be no excuse for the filling of this basin. But the city officials were so determined that this result should be accomplished that a rainmaker was hired to aid in the operation.

Under the conditions the writer is unable to accept Mr. Cromwell's invitation to retract former criticism and attribute the disaster to an act of God.

FRANCIS L. SELLEW.

La Jolla, Calif., April 24, 1916.

Pittsburgh Ruling on Flat-Slab Concrete-Floor Systems

Sir—There is appended hereto a copy of a ruling on four-way flat-slab construction in reinforced concrete which was adopted in the Bureau of Building Inspection of the City of Pittsburgh, Penn., while I was engineer of the bureau and which may be proposed as the requirement of the new building code of this city, if there are no serious objections to its form and meaning.

The ruling is intended to cover only the four-way systems. Other systems may be easily arranged for by introducing additional matter to cover such portions of the construction as are not covered in the ruling given. It is not intended to be a complete guide for the designer in his work, but as a very sure check to discover whether he has done his work correctly. The coefficients for the bending moments, which are the first point of investigation, were obtained by assuming the resisting section in the various tested buildings quoted in the accompanying table and calculating an equivalent uniform live-load from that one in the test which came closest to the assumed design load intended for the floor tested and then solving for the bending-moment coefficient in the usual way. The span used in each case was the clear distance between the edges of the column caps. This work was performed in the case of the direct bands as well as the diagonal ones and the results noted.

The divisor 16 for the positive moment in the center of the panel was selected because all the various forms of flat-slab construction are safe under this figure, even though the tests did not disclose stresses anywhere near those calculated by this method. But by this method the distribution of the steel in the diagonal bands must be properly arranged.

The great advantage of employing this method is that it is flexible. The design for the construction may vary according to the conditions of the loading and the span in a much more consistent manner than when the construction is limited by dimensions or proportions of the details. It allows to the designer the greatest latitude that is possibly consistent with safety of the construction and will invariably be found on trial to disclose to the investigator any error or deviation from the accepted test results which tends toward danger. If at first glance the reader thinks that the ruling is prohibitory, it will be best to reserve judgment until having given it a consistent trial. The principal result of its use is that the column cap is invariably made heavier than has been the practice in the past, but not so much as to be detrimental to the construction in any way.

The manner of dealing with rectangular panels will be easily understood and results in nothing different from the usual practice, which follows the theoretical laws for the variation in the bending moments in the case of two-dimension variations.

The formula for the resisting moment at the periphery of the drop construction is derived simply from the standard method of finding the bending moment at a certain section of a beam when the moment is known at another section and the shears between are to be multiplied by their acting arm in order to find the moment at the required section.

The ruling is not proposed as if completed, but in such an important matter as this it is best to have the light that may be shed upon it by those who may have had experiences which can show whether or not slight variations in the ruling would cause it to be of more correct or wider adaptability to the work on which it should be used. It is intended to bring out discussion of a constructive nature, as the writer is convinced that the method, when extended to cover the probable cases that may arise in its use, which can be found only by throwing upon it the light of careful scrutiny of the engineering profession, will be found to approach as near to the actual correct theoretical method as possible. It is only claimed to be based upon an empirical solution, but is not open to the usual objection that the constants used in the solution are not yet properly determined from a physical standpoint. Any such physical constants that may be considered will be found to have been accounted for in the fact that they affected the actual stresses in the tests and thus are actually accounted for in the formulas.

JOHN A. FERGUSON,

Secretary-Engineer of the Building Code Committee.

Pittsburgh, Penn., Apr. 25, 1916.

[The ruling and the table follow.—Editor.]

RULING ON THE DESIGN OF FLAT-SLAB CONSTRUCTION IN THE CITY OF PITTSBURGH

Definitions

1. Flat slabs, as understood by this ruling, shall consist of reinforced-concrete columns with enlarged capitals on which is supported a flat reinforced slab floor, with or without plates or depressed panels at the column cap. The construction may be such as to admit the use of hollow panels in the ceiling or smooth ceiling with depressed panel in the floor at the column cap.

COMPARISON OF STRESSES MEASURED IN EXTENSOMETER TESTS WITH STRESSES COMPUTED BY THE CHICAGO AND PITTSBURGH RULINGS.*

Building, City and Date of Test	Nature of Load	Loads in Lb. per Sq. Ft. Live	Dead	Total	Compression in Concrete at Edge of Column Capital: Actual Stress	Stress Computed by Chicago Ruling	Stress Computed by Pitts. Ruling	Tension in Steel Over Column Head: Actual Stress	Stress Computed by Chicago Ruling	Stress Computed by Pitts. Ruling	Tension in Steel at Center of Span: Actual Stress	Stress Computed by Chicago Ruling	Stress Computed by Pitts. Ruling
Deere & Webber	Design	225	115	340	750	750	780	16,000	28,600	19,000	4,000	14,700	11,300
Minneapolis, 1910	Test	350	115	465	1,000	1,030	1,150	24,000	39,200	26,000	7,000	20,200	15,400
Franks	Design	256	115	371	680	700	750	4,000	11,200	7,500	4,500	15,000	11,400
Chicago, 1911	Test	624	115	739	1,390	1,400	1,500	8,700	22,400	15,000	10,100	30,000	22,800
Larkin	Design	250	120	370	450	560	650	3,000	18,000	10,200	3,300	18,000	14,000
Chicago, 1912	Test	618	120	738	1,000	1,120	1,300	8,500	36,000	20,400	16,000	36,000	28,000
Excelsior	Design	150	125	275	350	580	600	3,500	16,200	9,950	2,600	20,500	15,700
Chicago, 1914	Test	425	125	550	720	1,160	1,200	12,100	32,400	19,900	15,000	41,000	31,400

* Table calculated by A. R. Lord.

2. The column capital shall be defined as the gradual flaring out of the column without any marked offset in the concrete.

3. The depressed panel shall be defined as a square, rectangular or approximately circular depression around the column capital extending below the adjacent slab.

4. The panel length shall be defined as the distance center to center of column of the side of a square panel, and the panel length and breadth of a rectangular panel as the distance center to center of column in the long and short directions respectively. The span length is defined as the distance in the clear from edge to edge of column cap where it intersects either the floor slab or the depressed panel, measured on the length or breadth of the panel as the case may be.

Stresses

5. All unit stresses shall be as specified in the general ordinance on the "Use of Concrete and Reinforced Concrete." Stresses shall be computed under the assumption set forth in that ordinance.

Moments

6. The negative bending moment at the support shall be taken $\frac{W' L'}{11}$, in which W' equals the total load on one panel exclusive of any load within the area of the column capital and L' is the clear span between column capitals measured along the side of the panel.

7. The positive moment at the center of the panel shall be taken as $\frac{W L}{16}$, in which W is the total load on a panel and L the distance center to center of columns measured along the side of the panel.

Resisting Sections

8. The negative moment at the support shall be considered as acting on a vertical section passing through the slab along the periphery of the column capital. The compressive stress in the concrete on this section shall be figured by the ordinary straight-line assumptions of stress distribution taking the periphery of the column capital as the width of the section and the depth from the lower face of the concrete adjoining the column capital to the center of gravity of the slab steel as the depth of the section.

9. The area of slab steel resisting the negative moment of $\frac{W' L'}{11}$ at the support shall be taken as the total section of all slab rods cutting a conical critical section starting at the periphery of the column capital and flaring outward at a 45° angle with the vertical. The spacing of rods thus determined for the width of the critical section shall be maintained for the full width of the bands.

10. The positive moment at the center shall be resisted by the steel and concrete cut by a vertical critical section through the slab having its center at the column center and its diameter equal to the mean dimension of the sides of the panel.

Drop Construction

11. The thickness of the slab adjacent to the column capital may be increased, if necessary, by means of a depressed concrete drop panel centered on the column center. Where this depressed panel is used, the resisting moment of the slag at the periphery of the depression shall be not less than that figured from the formula $M = W' \left(\frac{L'}{11} + \frac{X^2}{L'} - \frac{X}{2}\right)$, in which W' and L' are as defined above and X is the distance between the edge of the column capital and a circle of area equal to that of the drop used. This depressed panel may be diminished in thickness at greater distance from the column capital if desired, provided the resisting moment at any section shall not fall below the value determined by the above formula applied to that particular section.

Columns

12. The columns shall be figured for the unbalanced moment of the live floor load when the entire area on one side of a line through the column center is considered as loaded and the area on the other side unloaded. The live-load reaction producing this moment shall be considered as uniformly distributed along the periphery of the column capital.

Distribution of Slab Steel

13. The computed area of steel per unit width of band determined from the moment at the support shall be maintained the same for the entire width of each band. Width of bands shall not be less than four-tenths of the direct span between column centers. The total steel area as determined from the computations may be distributed equally between all the bands or somewhat more than one-half may be placed in the direct bands. In no case, however, shall the steel area of direct bands exceed that in diagonal bands by more than one-third (for square panels).

Rectangular Panels

14. The slab thickness and the steel area in the diagonal bands shall be determined in rectangular panels by computations based on a square panel of the same average dimensions. The steel area in the long direct bands shall be that required in the same band if situated on the edge of a square panel of the long dimensions in size. The steel area in the short direct band shall be that required in the same band if situated on the edge of a square panel of the short dimensions in size.

Profile of the Column Capital

15. The profile of the column capital shall satisfy the moment of $\frac{W' L'}{11}$ at any concentric vertical section through it and the slab, the value of W' and L' being taken for the particular section considered.

Moments in Wall Panels

16. The bending moment to be resisted by any band of reinforcing extending into an exterior panel shall be increased by 20% if concrete column supports are present at the wall and by 40% if the slab rests on a bearing wall at its exterior edge.

Concentrated Loads

17. Girders and beams shall be provided where necessary to carry concentrated loads in excess of the safe capacity of the floor slab. Such girders and beams shall be calculated for the full concentrated load.

Note—The unit stresses permitted in the ordinance on reinforced concrete above referred to are as follows:

	Lb. per Sq. In.
Compression in extreme fiber	650
Tension for steel in beams	16,000
Bond of concrete to steel	80
Shear in concrete unaccompanied by tension	120
Allowed tensile strain in concrete, diagonal, in beams	90
Tensile strain allowed in diagonal tensile stress	1,350

Status of Activated Sludge

Sir—In my article on the "Status of Activated-Sludge Sewage Treatment," published in the *Engineering News* of Apr. 27, 1916, there is a typographical error which affects the meaning and intent of the writer. On page 800, beginning at the 7th line from the top of the page, it is stated:

> As a preliminary to activation, the screen should not be too fine. An aperture less than ½ in. would probably remove material that should be activated, while larger than $\frac{3}{16}$ in. would admit substances that should be treated as screenings.

The first of these figures should have read $\frac{1}{32}$ instead of ½ in. The writer had in mind the Riensch-Wurl screen at Cleveland, which has $\frac{1}{32}$-in. apertures, as the finest permissible for use in this connection; while a screen of the same kind with $\frac{3}{16}$-in. aperture seemed the other limit.

GEORGE T. HAMMOND.

215 Montague St., Brooklyn, N. Y., Apr. 29, 1916.

Wood-Stave Water Conduits

Sir—I have read with great interest the article by Charles Evan Fowler, entitled "Seattle Water-Works Troubles," published in *Engineering News*, Mar. 30, 1916. Of especial interest was the reference to the cost of the main supply pipe. Since recent publications have given considerable publicity to these pipes, a discussion of their merits may not be amiss.

It seems that when these lines were contemplated a study was made of the respective merits of wood-stave and steel pipe, with the ultimate result that the wood-stave pipe showed a saving in cost over a period of 45 yr. of $1,413,756. Consistent with economy, as would be expected, wood-stave pipe was chosen.

Any pipe line, whether built of steel, wood staves or steel and concrete, should be protected against injury from outside causes. The pipe should be buried if exposed to danger from land slides or falling boulders; trestles or bridges should be located and designed with a view to protection from floods; air valves should

be of sufficient size and number to care for the relieving of vacuum or negative pressure created by sudden outflow of water in the pipe due to a break in the line or sudden opening of gate valves; and finally the design should provide an ample factor of safety against such overload as may arise from water-hammer, etc. With such precautions assumed, the merits of an economical installation depend upon total cost, including first cost, maintenance, depreciation and interest on the investment, and involve therefore the life of the pipe.

In designing the Seattle conduits wood-stave pipe was given a length of life equal to the usual assumed life of steel pipe, or 15 yr. I understand that concrete-and-steel construction was disregarded because its cost would have exceeded the amount of money available at that time. The matter then evolved into relative first cost, maintenance and interest on investment pertaining to steel and wood-stave pipe, the result being in favor of the wood stave. Assuming that all precautions for the protection of the line had been taken and maintained, there should not now be any question of the correctness of the judgment of the engineers in charge of the work in choosing wood-stave pipe.

However, there is one point that was overlooked or disregarded at the time of installation. This oversight is still a common one among engineers, and it occurs in the classification of wood-stave pipe as a whole, irrespective of the material from which it is made.

With wood-stave pipe of California redwood a cheap pipe is secured with a life that approaches permanent construction. Properly constructed pipe made of clear, air-dried redwood staves will give a life approaching that of cast iron; and while the first cost will be higher than that of treated fir or pine pipe, it will be less than that of steel, while the annual cost or sinking fund necessary to cover its renewal will be but a fraction of the corresponding reserve necessary to be considered in installing fir-stave or steel pipe.

The wood-stave pipe in Seattle (fir-stave pipe) was given as its maximum life 15 yr., the estimated life of steel pipe. The cost over a period of 45 yr. was figured to be $1,947,595—a saving of $1,413,756 over and above the cost of steel pipe for the same period. This included the first cost of the wood pipe ($322,952) and two renewals at a cost of $311,294, interest figured at 5%. Over 45 yr. this gave an average annual expenditure of approximately $43,280.

A wood-stave pipe, if made of redwood, would cost approximately 33⅓% more than the fir pipe, or $430,600. Assume a cost of $500,000 for the redwood-stave pipe. The life of a properly constructed pipe made of staves of the best quality of clear, air-dried redwood could be safely placed at 50 yr., while a longer life is probable. The approximate annual cost would be, on this basis, $10,000—an annual saving on this conservative estimate of $33,280.

A clearer comparison would be shown by assuming that the revenue derived from the sale of water would clear off the first cost of the fir pipe in 15 yr. This would leave two renewals at $311,294 each to be cared for in the following 30 yr., figuring that a concrete-steel pipe would be in operation replacing these lines at the end of that time. If redwood pipe were used, the first cost of $500,000 would at the same rate be paid off in 23 yr., the pipe for the remaining 22 yr. costing the city nothing.

A great many redwood-stave pipes have been installed throughout this country and other countries during the past 30 yr., and investigation has revealed them to be still in excellent condition, good for many more years of service. An assumed life of 50 or more years is readily admitted by those who are familiar with this type of pipe construction.

Some wood-pipe lines built with redwood staves, with dates of installation, are given in the accompanying table. Any of these lines can be personally investigated by engineers desiring data in order to be convinced of the merit of redwood.

It is not necessary to go to the expense of a cast-iron or concrete-steel pipe to secure a pipe that will give continued service over a long period of years. To renew

SOME REDWOOD-STAVE PIPE LINES INSTALLED FROM 1889 TO 1908

Installed	Owner	Location	Diameter, In.
1889	City of Ogden	Provo, Utah	14
1891	City of Provo	Ogden, Ariz.	18
1892	City of Logan	Logan, Utah	18
1892	City of Yuma	Yuma, Ariz.	26
1892	Butte City Water Co.	Butte, Mont.	24
1899	Butte City Water Co.	Butte, Mont.	26
1893	Kern County Land Co.	Bakersfield, Calif.	72
1893	Mt. Nebo Land Co.	Mt. Nebo, Calif.	48
1894	Oakland Water Co.	Oakland, Calif.	20
1895	William Inayes	Montpelier, Idaho	24
1897	North Star Mines Co.	Grass Valley, Calif.	14
1898	City of Palto Alto*	Palo Alto, Calif.	12
1899	Yuba Electric Co.	Marysville, Calif.	36
1899	Floriston Pulp and Paper Co.	Floriston, Calif.	108
1900	Reno Light and Power Co.	Reno, Nev.	48
1900	Honolulu Plantation Co.	Honolulu, T. H.	24
1900	Kihei Plantation Co.	Hawaiian Islands	24
1900	Moonlight Water Co.	Nome, Alaska	14
1901	Hawaiian Sugar Co.	Mauli, T. H.	24
1901	Southern California Mountain Water Co.	San Diego, Calif.	24
1901	Anaconda Copper Co.	Anaconda, Mont.	66
1902	Melones Mining Co.	Melones, Calif.	72
1902	Los Alamitos Sugar Co.	Los Alamitos, Calif.	18
1903	Utah Sugar Co.	Garland, Utah	24
1903	Vancouver Power Co.	Vancouver, B. C.	54
1903	Idaho Sugar Co.	Idaho Falls, Idaho	24
1904	Cornell University	Ithaca, N. Y.	60
1904	Idaho Construction and Power Co.	Idaho Falls, Idaho	120
1904	City of Lynchburg	Lynchburg, Va.	30
1905	Great Northern Power Co.†	Duluth, Minn.	84
1905	City of Greensboro	Greensboro, N. C.	24
1905	Cerro de Pasco Mining Co.	La Fundicion, Peru	22
1905	City of St. John	St. John, N. B.	33
1905	City of Dallas	Dallas, Tex.	42
1906	Guanajuato Power Co.	Zamora, Mexico	69
1906	Mill Creek Power Co.	Salt Lake City	22
1906	Garfield Water Co.	Garfield, Utah	141
1906	Utah Copper Co.	Bingham, Utah	24
1907	North Fork Ditch Co.	Folsom, Calif.	52
1908	City of Temple	Temple, Tex.	18
1908	French Land and Irrigation Co.	French, N. M.	42

*Sewer pipe; no pressure; laid in salt marsh. †Four parallel lines.

pipe lines every 15 yr. when 30% additional expenditure at first would more than double the life would seem poor engineering and economy. A thorough, economical study of available material for a pipe line should be given more careful consideration by all engineers. Just as the quality of cast iron and steel is known to vary, so should the quality of various kinds of lumber for different uses be appreciated. Fir and pine for strength, redwood for durability, should be as thoroughly understood as steel for strength and cast iron for durability.

JOHN F. PARTRIDGE.

Hobart Building, San Francisco, Calif., Apr. 8, 1916.

NOTES AND QUERIES

The Diagonal Station Drawing reproduced as Fig. 5 of P. A. Sealey's article on "Rapid-Transit Work in 1915, New York City," p. 846, May 4, 1916, was unfortunately not credited to its author. The original was drawn by George Perrine, Assistant Engineer, Rapid Transit Subway Construction Co., and was distributed to a visiting party of the American Society of Civil Engineers last January.

Grease and Fertilizer Base from Boston Sewage*

By Robert Spurr Weston†

Experiments to determine the feasibility of a new process of sewage treatment invented and patented by George W. Miles, a Boston chemist, were made from 1911 to 1914 under the direction of E. S. Dorr, of the Boston Sewer Department, with results that seem to indicate that it will be not only successful, but profitable. The process may be described as follows:

Ordinary sewage sludge from settling basins is greasy, offensive and of so little practical value that farmers will not accept it for fertilizer, even as a gift, yet sewage sludge contains fertilizing elements of great value and considerable grease. The Miles process attempts by the addition of an acid to precipitate the bulk of the solids from sewage in the form of a sludge that can be dried and degreased, thereby producing a readily salable and greaseless fertilizer, as well as recovering the valuable grease. Either sulphuric acid or sulphurous acid may be used, and the process contemplates the manufacture of the acid at the disposal works. If sulphuric acid were chosen, ordinary weak chamber acid of 1.53 specific gravity would be used, but the cheapest source of acid is undoubtedly pyrite (native FeS_2), which when roasted in a furnace of proper construction produces sulphur dioxide (SO_2). This is a gas that may be fed directly into the sewage, in which it would dissolve, forming sulphurous acid.

The addition of sulphur dioxide precipitates most of the grease, together with the greater part of the suspended matter. The resulting sludge is dried, extracted with a solvent to recover the grease, and the remainder prepared for fertilizer. An important sanitary feature of the treatment is that the sulphur dioxide is a strong disinfectant, so that the acidified sewage contains few bacteria. It also contains but little suspended matter. Consequently, the supernatant liquid may be discharged into a body of water like Boston Harbor without producing any nuisance.

The experiments, which were conducted by officers of the sewer division of the City of Boston, consisted of 11 runs, involving the treatment of about 26,000 gal. of sewage. From these experiments it was concluded that from 1,000,000 gal. of sewage 1,738 lb. of dried sludge would be obtained and that it would contain 21.7% of grease, which at 4c. a pound would yield $15.08. In addition, there would be 13.61 lb. of fertilizer base, estimated according to agricultural standards to be worth $9.25, making the total value of the recoverable material about $24.33 per 1,000,000 gal.

The results of Mr. Dorr's experiments were so promising that their repetition under the supervision of impartial investigators and for a longer period was thought worth while, and arrangements were made for a week's study of the process under the supervision of the sanitary-research laboratory of the Massachusetts Institute of Technology. These further experiments were begun on July 7, 1915, and were made under the direction of Robert Spurr Weston, with Prof. W. T. Sedgwick in consultation. The results obtained were checked by further experiments, covering three days, which began on Nov. 8, 1915, so that the tests covered both warm- and cold-weather conditions. The close agreement between the results of the two sets of experiments is remarkable, and it may be definitely stated that the experiments of the sanitary-research laboratory confirm the results obtained by Mr. Dorr regarding the amount of sludge that may be recovered from Boston sewage and the amount of grease that is present therein. The Miles acid process has thus been shown to possess many advantages as a method of sewage disposal for cities like Boston, namely:

1. It disinfects the sewage by reducing the numbers of bacteria from millions to hundreds per cubic centimeter.

2. If the drying of the sludge and the extraction of the grease can be accomplished economically, it is probable that a large part, if not all, of the cost of the acid treatment may be met by the sale of the grease and fertilizer recovered from the sewage.

3. The use of so strong a deodorizer and disinfectant as sulphur dioxide would prevent the usual nuisance of treatment works. The experiments have shown that the sludge can be held at the works for four days during the heated season without giving off offensive odors, while the effluent is inoffensive and stable enough to be discharged into Boston Harbor without the slightest probability of creating a nuisance.

4. The addition of sulphur dioxide to the sewage also avoids any fly nuisance, which is a handicap to the operation of Imhoff tanks and trickling filters. This fact, with the absence of odor, would be a great advantage to any plant located at Moon Island and would probably cause a great appreciation in value of the surrounding property.

Drying of the sludge and the extraction of the grease are absolutely essential for the success of the process. Mr. Dorr's figures, which show profits of from $6 to $11 per 1,000,000 gal., appear high, and it is possible that he has allowed too little for the acid and for the cost of drying the sludge; but even if his figures be doubled, the process is still well worthy of consideration by the City of Boston, because of its freedom from nuisance, as it produces an effluent which is practically free from disease germs and which can be discharged into the harbor with impunity.

With the facts at hand, the process would be very satisfactory for Boston from a sanitary standpoint and is more promising economically than any other known. The value of Imhoff tank sludge is hardly enough to pay for the drying; at Milwaukee, Chief Engineer Hatton estimates the total value of activated sludge at from $9 to $15 per 1,000,000 gal., while our Boston experiments have proved that the sludge from the Miles process, although less in bulk than that from the activated-sludge process, has a value of more than $24 per 1,000,000 gal. of sewage. Correcting Mr. Dorr's estimates for the higher amounts of acid which these experiments show to be necessary, one gets $18 per 1,000,000 gal. as the average cost of treatment, and $6 as the margin of profit. While it is believed that this estimated margin of profit is too high, the writer is unable, by any reasonable comparison with analagous cost data from other sources, including his experience, to wipe it out. Furthermore, the size of the Moon Island plant and the tanks already in existence there are all in favor of a reduced rather than an increased cost of treatment.

*Abstract of a paper in the "Journal" of the American Public Health Association, April, 1916.

†Consulting Sanitary Engineer, 14 Beacon St., Boston, Mass.

News of the Engineering World

Parkersburg Suspension Bridge Opened to Traffic

A new highway crossing of the Ohio River was put into service Apr. 29 with the formal opening to traffic of the suspension bridge between Parkersburg, W. Va., and Belpre, Ohio. The bridge, located 280 ft. below the Baltimore & Ohio R.R. crossing, has two electric-railway tracks in a roadway of 22 ft. clear width and one 6-ft. sidewalk. The design contemplates the use of interurban cars weighing 50 tons each, a live-load of 100 lb. per sq.ft. of roadway and a 16-ton road roller for maximum floor concentrations.

The total length of the bridge is 2,856 ft., comprising 700 ft. of viaduct approach at the Parkersburg end, a 200-ft. through-truss span, three suspension spans—375, 775 and 275 ft. in length—and 500 ft. of approach at the Belpre end. The approaches are plate girders, 40 to 117 ft. in span. A required clearance of 90 ft. above low water for the main-channel span, together with rather low banks, necessitated the use of 5¼% grades for the approaches; elsewhere 2% grades are used, except for the Belpre side span, which is on a 4% grade.

Two of the river piers are founded on rock, 16 ft. below the bed of the river. The other pier and the Parkersburg anchorage rest on piling, and the Belpre anchorage on sandy clay. There are 13,000 cu.yd. of concrete in the substructure.

Each of the cables has an area of 40.8 sq.in. net section and contains seven strands of No. 8 wire. The ultimate strength of the wire is 230,000 lb. per sq.in., the elastic limit about 150,000 lb. per sq.in. and the working stress 50,000 lb. per sq.in. under full load. After the erection of the towers by floating derrick and gin pole a temporary cable was strung from anchorage to anchorage over the position of each main cable. Each strand of the main cables was built up on shore, special precautions being taken to insure that the wires would take uniform tension in service. The strands were then hauled across the river with the aid of the temporary cables, from which they were slung. When in proper position, they were placed in the cast-steel clamps at the tops of towers, rocker bent and attached to the anchorage eye-bars. Men working in erection cages suspended from the cables placed temporary clamps to hold the strands in proper relative position. The cables were then wrapped, using a rig very similar to that employed for the same purpose on the East River bridges. Lastly, the hanger rods were attached by cast-steel clamps and the erection of the floor system started.

Steel was brought out on barges and erection carried both ways from each tower, using light jinnywink der-

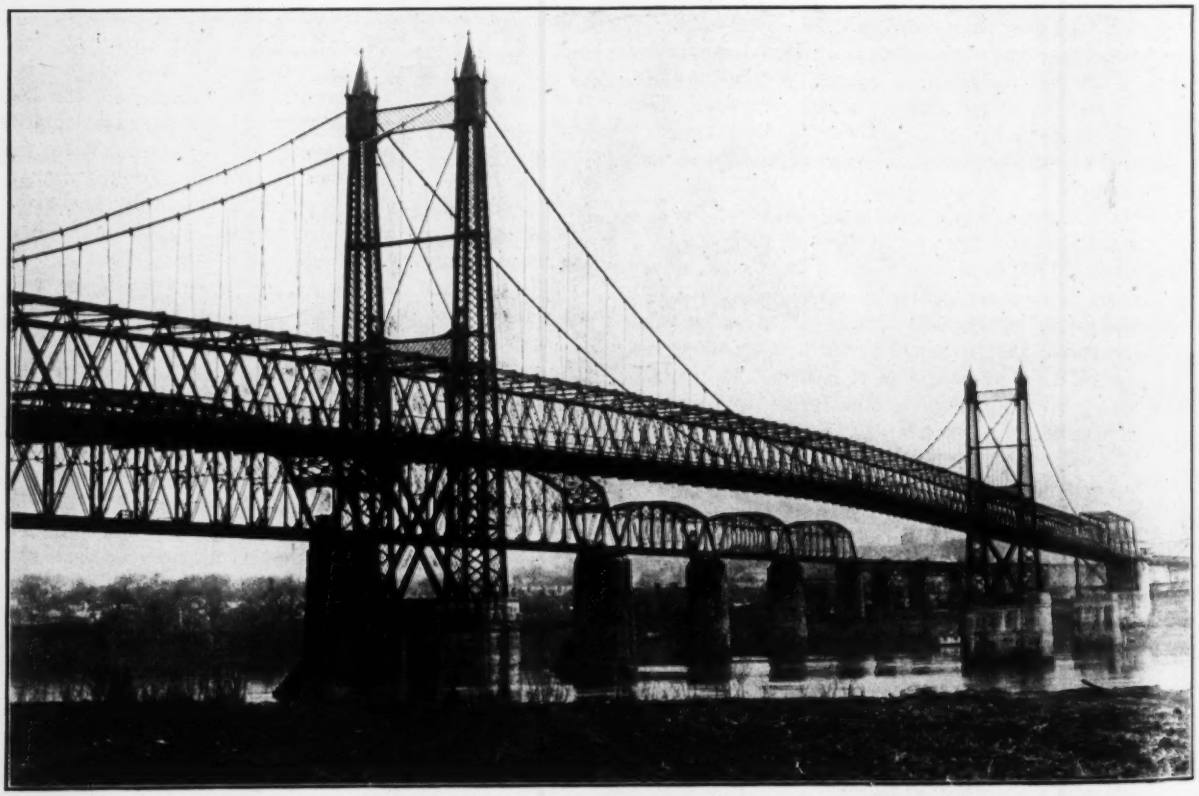


FIG. 1. NEW HIGHWAY BRIDGE ACROSS OHIO RIVER AT PARKERSBURG, W. VA.

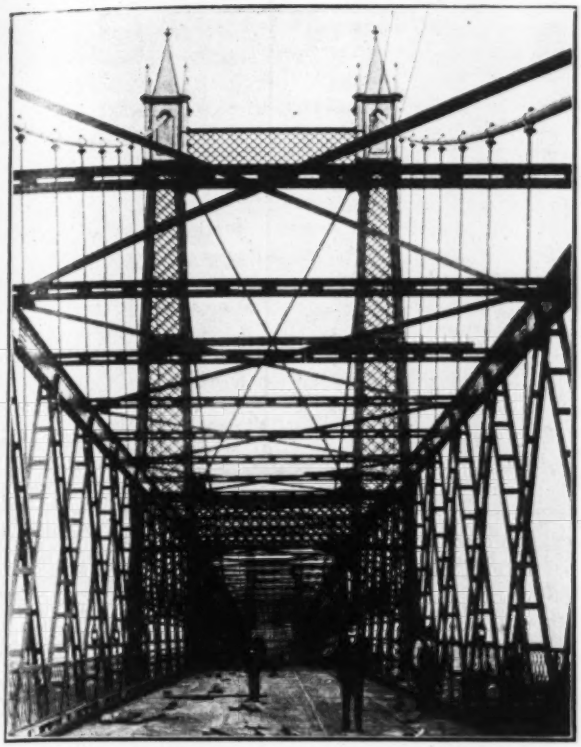


FIG. 2. ROADWAY OF PARKERSBURG BRIDGE

ricks. The floor system, consisting of four lines of track stringers and one line of sidewalk stringers, with lateral bracing, was practically completed before any work was done on the stiffening trusses. The steel for these was strung out along the floor to give approximately the proper dead-load profile to the bridge and was then placed by the same jinnywinks.

The stiffening trusses are 21 ft. deep and spaced 24 ft. apart c. to c. They have box chords and double-angle diagonals. Rocker-bearing expansion joints for the stiffening trusses occur at the towers; the outer ends are fixed. There is a sliding joint at the center of the upper chord of the main-channel span, while the bottom chord of the span is continuous throughout. The three middle floor-beams are fixed to the cables so as to divide the expansion equally between the two halves of the span. Where the cables intersect the top chords of the stiffening trusses, special wind struts are provided, and there is a top and bottom lateral system of angles.

The two main towers are composed each of eight open columns, braced in fours to form two pedestals, and anchored well down in the pier.

The decking of the 200-ft. span and the suspension spans is of long-leaf yellow pine treated in hot Carbolineum Avenarius. The approach spans have a reinforced-concrete floor and sidewalk and are brick paved.

The bridge cost $440,000, including right-of-way, and took 13 months to build. The owner is the Parkersburg-Ohio Bridge Co., Hermann Laub, Consulting Engineer; R. C. Venable, Supervising Engineer; and L. W. Jacobs, Resident Engineer. Laub & Stuart had the general contract. Substructure work was done by the Dravo Contracting Co.; the steel was fabricated by the American Bridge Co. and erected by Pittsburgh Construction Co.

"War-Engineering Applied to Man-Slaughter"

"Engineering applied to man-slaughter" was Col. F. R. Shunk's definition of modern war at the first lecture (May 3) on military engineering in the series arranged for the technical men of the Pittsburgh district by the Engineers' Society of Western Pennsylvania. There were 1,500 men at the lecture in the Carnegie Institute auditorium. Colonel Shunk's topic was "Organization and Duties of Engineer Troops," and he showed the meagerness of the present corps and how it would have to be expanded in time of war.

In connection with Isham Randolph's suggestion that civil works be taken from the Army Engineer Corps, Colonel Shunk cited the military work that is now impossible—such as making detailed military maps on a scale of 12 in. to the mile. He had hoped, when first detailed to the important district of Pittsburgh, to be able to squeeze in the mapping of the surrounding country, but it had been impossible. He mentioned, however, the advantages of the training given the Army Engineers by the civil works—knowledge of construction methods, business dealings and handling of men without autocratic authority.

Federal Legislation Likely for Flood Control

The Humphreys bill, providing for Federal action to control the floods of the Mississippi River, was favorably reported to the House of Representatives on Apr. 29 by the newly created Committee on Flood Control. The bill authorizes the Secretary of War to spend not more than $15,000,000, either by contract or by day's work, in carrying out the plans of the Mississippi River Commission for the regulation of the Mississippi, not more than $10,000,000 of this amount to be spent during any one fiscal year. Appropriations for the work are to be made in the Sundry Civil bill. The money is to be expended between the Head of the Passes below New Orleans and the mouth of the Ohio River. This means of course that the money is to be expended in levee construction and bank revetments. Where money is spent on levee construction the local interests affected must contribute at least one-third the cost of the work and free right-of-way must be provided.

The bill further provides that not more than $5,600,000 may be spent for flood control on the Sacramento River in California, at the rate of not more than $1,000,000 per year, with the provision that the state must contribute to the work an amount at least equal to the Federal expenditure.

The third section of the bill provides that the Corps of Engineers, under direction of the Secretary of War, will have charge of all expenditures for flood control under the provisions of this bill and may make investigations and reports on works for flood control on other rivers. In making such investigations, the report is to show the extent and character of the area benefited by the proposed improvement, the effect upon any navigable waterway, the possible development of water power, and any other benefits which may result from the project.

The Committee on Flood Control is a special committee created by the House on Feb. 3. The committee

took a trip down the Mississippi from Cairo to New Orleans during the February flood and favorably reported the bill to the House on Apr. 29, only eleven days after its introduction. The bill was considered by the House in committee of the whole on May 3 and the sentiments expressed in the debate indicate its probable passage at an early day. It is reported that the Senate also is likely to give it favorable consideration.

Federal Aid Road Bill Passes United States Senate

The Bankhead bill for Federal aid to state road construction passed the Senate on May 8. The bill appropriates $5,000,000 for the year ending June 30, 1917; $10,000,000 for the year following and further increases of $5,000,000 each year until 1921, when $25,000,000 will be available. The appropriation is to be apportioned to the different states by the Secretary of Agriculture, one-third in the ratio of the area of the state to the total area of the country, one-third in the ratio of the population in the state to the total population, and one-third in the ratio of the mileage of rural delivery routes of the state to the total mileage of the country. In addition, the bill appropriates $1,000,000 annually, beginning with the year ending June 30, 1917, for "the survey, construction and maintenance of roads and trails within or partly within the national forests, when necessary for the use and development of resources on which communities in and near the national forests are dependent." The bill as passed by the Senate is a substitute for the Shackleford bill which the House passed early in the session, which appropriated $25,000,000 for Federal aid.

Federal Trade Commission for Export Trade Co-operation

The Federal Trade Commission announces the result of an extended investigation of competitive conditions in international trade. It finds that America is handicapped in its export trade by the superior organization of foreign manufacturers and exporters. It urges on Congress immediate legislation permitting combination and coöperation among American firms in the conduct of export trade. While at the present time the United States is enjoying an enormous and unprecedented trade with other nations, a large part of this trade is due to war conditions, and much of it is being done on terms and by methods which are alienating the purchasers and will insure the reversion of their trade to other countries at the first opportunity.

The foreign nations with whom we must compete have built up their ocean shipping, granted low export railway rates and established foreign trade banks, all of which operate together to give the foreign exporter an advantage over his American competitor.

Reviewing the foreign combinations which compete with American exporters, the commission says that there were in Germany prior to the war 600 important cartels or combinations to control prices, embracing practically every industry in the Empire. For example, two great companies which work in harmony with each other, the Algemeine Electricitats and the Siemens-Shuckert, control the bulk of the manufacture and export of electrical equipment. Half of the $150,000,000 worth of coal and coke exported is handled by the great Rhenish Westphalian Coal Syndicate, a combination of coal producers of which the government-owned mines are members. Practically all of the iron and steel export business in Germany is handled by a single sales agency, the Stahlwerks Verband.

An organization of Japanese textile manufacturers is rapidly obtaining the rich cotton goods trade of North China. In Great Britain, a large part of the export business is done by individual firms, relying upon their long experience and established reputation. Nevertheless in many industries associations of manufacturers have been formed to handle the export trade.

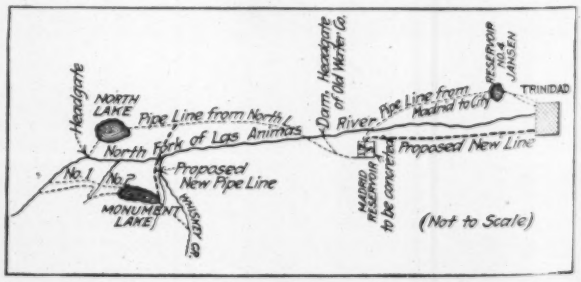
Besides foreign combinations of foreign firms in the export trade, other combinations limit competition in the purchase of American goods. A combination of British coal brokers fixes the price for bunkering ships at Newport News.

The commission recognizes the danger that coöperative export organizations of American manufacturers might attempt to control prices in the home market as well and also that such combinations might be used to the injury of the individual American exporter. The commission recommends that these dangers be met by an extension of the law prohibiting unfair methods of competition in export trade and by the enforcement of the anti-trust laws in connection with domestic trade.

Water-Supply Improvements, Trinidad, Colo.

The City of Trinidad, Colo., the center of the state's coal-mining activities, has a municipal water-supply in the mountains above the city. The collecting reservoirs are natural lakes about 27 mi. from the city. Water from the mountain creeks forming the North Fork of the Las Animas River is conducted to these reservoirs by a system of pipes and open ditches. Only one of these lakes, known as North Lake, has been fully developed as yet.

The city has just begun the expenditure of $185,000 for improvements and additions. Water from North Lake is now conducted by a single main to the Madrid reservoir, about 8 mi. from the city; from here a single main carries the water through another reservoir to the city mains. The improvements under way include a new 24-in. wood-stave main from the Madrid reservoir to the city by a new route and the lining of the Madrid reservoir with concrete. Ultimately the other lake, known



SKETCH PLAN OF WATER-SUPPLY OF TRINIDAD, COLO., SHOWING CONTEMPLATED IMPROVEMENTS

as Monument Lake, will be connected with the present main between North Lake and the Madrid reservoir.

The Madrid reservoir lies over a coal seam and leaks badly. It is divided into three compartments or basins—one of 80,000,000 gal. and two of 10,000,000 gal. capacity each. These are to be completely lined with concrete slabs. The work is to be done by day labor under the supervision of M. R. Lewis, Chief Engineer of the Trinidad water-works.

New Potomac River Bridge

A recent act of Congress, unless vetoed by the President, assures the construction of a new bridge across the Potomac River at Washington to replace the old Aqueduct bridge at the north end of the city. The Aqueduct bridge, crossing between 36th St. in Georgetown, D. C., and Virginia, was built 80 years ago to carry the Chesapeake & Ohio canal across the river on its way to Alexandria. The original structure was a series of wooden arches on cut-stone piers and was built between 1835 and 1840. In 1887, the aqueduct having been removed, the wooden arches were replaced by an iron highway bridge of nine Pratt truss deck spans, each 114 ft. long, and one through span, all on the old piers. For many years there has been trouble with the foundations of these piers, which were being undermined by high and swift water, and several difficult and expensive repair operations had to be undertaken (see *Engineering News*, July 26, 1900, p. 54).

The bridge for some time has been in an unsatisfactory condition, particularly as the traffic over it has increased at a great rate during the past ten years. The new bridge is to be built by the Federal Government at an adjacent site. It will make the third bridge across the main branch of the Potomac at Washington, the other two being the Highway bridge, replacing the old Long bridge, and the immediately adjacent Southern Ry. bridge. A fourth bridge, projected but never authorized, is the Memorial bridge between the Mall and Arlington, for which prize designs were accepted some years ago.

The new Aqueduct bridge is to be built by the Corps of Engineers, U. S. A., but will be maintained by the District of Columbia. A sum of $1,000,000 has been appropriated for the bridge and $150,000 for preparation of plans.

Cause of the New York Central Wreck at Amherst, Ohio, on Mar. 29, described in "Engineering News" of Apr. 6, was found by the Interstate Commerce Commission and the Ohio State Utilities Commission to be the inattention of Engineman Hess, who was on the second section of train 86 which ran into the rear of the first section, the wreckage of both being plowed through by the Twentieth Century Limited, running on an adjoining track. The report states:

> We believe that the engineman of second 86 failed to observe the caution indications at signal S9-2 and the stop indication at signal S7-2 (first and second signals, respectively, west of the point of collision), and that this was the direct cause of the accident.

Steel Trestle Bent Fell—One man was killed, two others were severely injured and a fourth escaped by jumping when a bent of a steel trestle which was being dismantled on the Bessemer & Lake Erie R.R., near Tarentum, Penn., toppled over. The girder span supported by the bent had been removed and the men were ready to make fast the main falls of the derrick car so as to lift up the bent and lower it to the ground. The bent was guyed with temporary lines, but became overbalanced and tore loose from the guys. The man who was killed was working at the top of the bent and fell the entire 90 ft. and was crushed. The one who escaped showed remarkable coolness and presence of mind by crawling from the lower to the upper side of the steelwork as it started to go, and then jumping as it neared the ground. He landed uninjured in a piece of swampy ground.

A Terminal Warehouse and Docks at Bayonne, N. J., are under consideration by Irving T. Bush, the founder and president of the well-known Bush Terminals at Brooklyn, N. Y. It is reported that Mr. Bush has agreed to construct a $20,000,000 plant, similar to that at Brooklyn, on the New York Bay shore of Bayonne, provided property and franchise rights can be arranged.

The Marseilles-Rhone Canal Tunnel, described in "Engineering News," Aug. 26, 1915, p. 386, was officially opened on May 7. This tunnel, 72 ft. wide, 40 ft. high and 4½ mi. long, is under the height of ground shoreward of Marseilles, France, and forms the southern end of the canal connecting that port with the River Rhone. It was thought that work on the tunnel had been suspended during the war, but evidently it has been kept up.

Mechanical Filtration and Disinfection of water from the Sacramento River have been recommended for Sacramento, Calif., by Prof. Charles Gilman Hyde, Berkeley, Calif., and George Wilhelm, Oakland. The estimated cost of a 30,000,000-gal. plant, which could be operated at a higher rate occasionally, is $1,288,000, most of which is for pumping and piping systems. Estimates for well and for mountain supplies are $1,315,000 and $10,000,000 respectively.

Sewage Disposal at New Haven, Conn., is to be studied by a commission of citizens acting with the five members of the aldermanic committee on sewers and sanitation. The citizen members are Henry B. Sargent, Albert B. Hill, Prof. C.-E. A. Winslow, Frank L. Homan and Howard F. Webb. Only preliminary investigations can be made this year, as no appropriation for the work of the commission has been provided. F. L. Ford is City Engineer of New Haven.

Prizes for Road Maintenance in Cuyahoga County, Ohio, are offered by the Efficiency League of Cuyahoga County, an organization made up of public officials of the various towns and cities in the county and of private citizens. Through the efforts of the County Highway Superintendent, W. A. Stinchcomb, arrangements have been made to award prizes to the town or city officials who do most efficient work in the maintenance of highways during 1916. Clayton W. Tyler, of Cleveland, is president of the Efficiency League.

New York Connecting Railroad Increases Bonds—A further bond issue of $8,000,000 is to be made by the New York Connecting Railroad. The total authorized issuing power of the company is $30,000,000, which sum is the estimated expenditure for its entire line through New York City. So far only $16,000,000 has been issued. This amount has been spent mainly on the viaduct portion of the line, from the Port Morris side of the East River via Randalls Island and Wards Island to Sunnyside Yard of the Long Island R.R. The new issue is to run 40 yr., at 4½%, and be redeemable at 105. The bonds must be sold at not less than 94.

The North Jersey Water-Supply Commission was appointed by Governor Fielder on May 5, in accordance with a legislative act. The object of the commission is to construct a dam and reservoir in the vicinity of Wanaque and a conduit therefrom to supply a number of cities and towns in northern New Jersey. The commissioners named are George F. Wright, Paterson; Ernest C. Hinck, Montclair; Dr. Wm. E. Ramsey, Perth Amboy; and Laurent J. Tonnele, of Bayonne. The last two are members, and Mr. Wright was once a member, of the State Water-Supply Commission, the functions of which on July 1 will go to the Department of Conservation and to new water-supply commissions for the northern and southern parts of the state. The North Jersey commissioners are to have cumulative probationary salaries of $1,500 a year each until a contract to supply a municipality has been signed, and $3,000 a year thereafter. It is expected that the North Jersey Commission will carry out the project reported on in 1911 by Morris Sherrard, Consulting Engineer, State Water-Supply Commission, Newark, N. J., in behalf of Newark, Paterson, Elizabeth, Montclair, East Orange, Totowa, Glen Ridge and Nutley.

Wages on Government Railroad Construction Work in Alaska have been adjusted by agreement between the Alaska Engineering Commission and the labor union at Anchorage. Work on the railway has been interfered with for several weeks by a strike for higher wages. The services of a Federal Board of Arbitration were brought in to settle the strike. The scale of wages agreed upon, according to an Associated Press dispatch, as follows:

> Section labor, 40¾c. an hour. Common labor, other than section men, 45c. an hour. Station laborers, track men and

experienced railroad construction workers, 46⅞c. an hour. Powder men, plumbers' helpers, machinists' helpers, blacksmiths' helpers, carpenters' helpers, 53⅛c. an hour. Longshoremen, 56¼c. an hour. Piledrivers and structural iron helpers, 60c. an hour. Steam engineers, ship caulkers, carpenters, blacksmiths and machinists, 70c. an hour. Plumbers, 75c. an hour. Steam-shovel engineers, $180 a month. Cranemen, $140 a month. Mule packers, $120 a month. Teamsters, $85 a month. Cooks, $90 to $120 a month. Operating department: Locomotive engineers, 70c. an hour. Conductors, 65c. an hour. Firemen, 46c. an hour. Brakemen, 44c. an hour.

Wire-Drag Resurvey Begins on Massachusetts Coast—The United States Coast and Geodetic Survey is about to make a resurvey by wire drag of Massachusetts Bay between Nahant and Cape Ann and of the western part of Cape Cod Bay between Plymouth and Cape Cod Canal. In Salem and Gloucester Harbors, the wire drags will be set at 33 ft. (mean low water). Elsewhere the maximum depth selected is 50 ft. at mean low water or 58 ft. at high water. The work will interfere temporarily with the operations of the fishermen, especially lobstermen, and it is essential that fishing operations be temporarily suspended in the particular localities where the work is in progress. In order to cause the least interference with the progress of the work and the operations of the fishermen, the area to be dragged is divided into sections about 5 sq.mi. in area. Charts showing the outlines of these sections, the order in which they will be dragged and a complete description of the method of buoying the section, are posted in post offices and other public places. Notices are attached to these charts from time to time to indicate the progress. Two parties will be engaged in this work, which will be carried on from May 15 to Oct. 15. They will have headquarters at Salem and Plymouth.

An Investigation of Canadian Railways is proposed by the Dominion Government, which has asked Parliament to pass an appropriation of $150,000 to defray the expenses of a commission to be appointed to investigate the condition of the Government-aided railways. The immediate cause for the creation of this commission is the inability of two of the Government-aided enterprises, the Canadian Northern and Grand Trunk Pacific, to meet the interest charges on the lines that have been built. Under present financial conditions these companies have not the money available to meet their interest charges and are unable to obtain new capital. To avoid throwing these great enterprises into bankruptcy the Government brought in a bill on May 2, providing for a loan of $23,000,000 by the Government to these companies. Of this amount, $15,000,000 is to go to the Canadian Northern to meet the interest charges on bonds, purchases of new rolling stock and new construction. The Grand Trunk Pacific will receive $8,000,000 to meet its interest charges, with a possible deficit in operating expenses and purchase of additional rolling stock. Both loans are to bear 6% interest, are repayable on demand and are to be secured by mortgage. The Government would have supervision of the expenditure of these loans. It is possible that the appointment of the new commission is a preliminary step to the taking over of one or both of these railway systems by the Government.

PERSONALS

Mr. John R. Sexton will succeed Mr. Carl W. Bucholtz as Division Engineer of the Meadville division of the Erie R.R.

Mr. Anthony Deahl, Attorney, of Goshen, Ind., has been appointed a Member of the Indiana Public Service Commission, by Governor Ralston, to succeed Charles J. Murphy, who recently resigned.

Mr. R. K. Brown, Division Engineer of the Salt Lake division of the San Pedro, Los Angeles & Salt Lake R.R., has been made Maintenance-of-Way Engineer of that railroad, with headquarters at Los Angeles, Calif.

Mr. Fred W. Waterman, M. Am. Soc. M. E., Chief Engineer and Acting Manager of the Lorain, Ohio, plant of the National Tube Co., will hereafter be Manager of the company's new tube plant to be constructed at Gary, Ind.

Mr. Halford Erickson, Chairman of the Railroad Commission of Wisconsin, has resigned to become associated with William Hagenah as practicing public-utility expert. His headquarters will be in the First National Bank Building, Chicago, Ill. Mr. Erickson has served on the Railroad Commission since its creation in 1905.

Mr. E. F. Mitchell, formerly Engineer of Construction and Chief Engineer of the Missouri Pacific System and for several years past engaged in the practice of consulting engineering, has been appointed Group Engineer of the Western Group of the Presidents' Conference Committee on Fo[illegible] tion of Railroads. His headquarters will be at [illegible]

Mr. Eli B. Heisler, formerly Assistant Engi[illegible] the Girard Estate mining operations in Schuylkill [illegible] Counties, Pennsylvania, has been appointed Se[illegible] City Engineer of Pottsville, Penn. Mr. Heisler [illegible] ate of Pennsylvania State College. For a short [illegible] was engaged as Junior Engineer in the United States [illegible] Service in Montana.

Messrs. George W. Tillson, M. Am. Soc. C. E., [illegible] G. Shirley, M. Am. Soc. C. E., and Arthur H. Blanchard, M. Am. Soc. C. E., a Commission of Engineers appointed by the Wilmington (Del.) Chamber of Commerce, have recently submitted a report on the administration, construction and maintenance of highways that are under the jurisdiction of the Levy Court of New Castle, Delaware.

Mr. Edmund M. Blake, who has been for some years Engineer in Charge of the Neponset River Improvement for the Massachusetts Department of Health, has accepted the position of Engineer to the Holbrook, Cabot & Rollins Corporation in the construction of the new dry-dock at Boston, Mass., which that company is building for the Directors of the Port of Boston. Mr. Blake was formerly Engineer on the Arrowrock Dam, at Boise, Idaho.

Mr. Walter Rowland, M. Am. Soc. C. E., has resigned as Assistant Engineer in Charge of Design of Docks and Piers, at Balboa, the Pacific terminal of the Panama Canal, comprising 2,490 lin.ft. of reinforced-concrete docks, 2,970 lin.ft. of steel docks and a 1,000-ft. reinforced-concrete pier, valued at $3,400,000. He is considering an offer from the Chile Exploration Co. to accompany Mr. S. B. Williamson, M. Am. Soc. C. E., in the development of west coast mineral properties at Chuquicamata and Braden.

Mr. Albert W. Walker, Assoc. M. Am. Soc. C. E., has been appointed Engineer in Charge of Investigations, Plans and Estimates of the newly formed Grand Valley Drainage District, with headquarters at Grand Junction, Colo. This district comprises about 50,000 acres of waterlogged land in the Grand Valley. Mr. Walker is a graduate of the Massachusetts Institute of Technology. He has been engaged with the United States Reclamation Service since 1905, for the past three years in charge of drainage on the Huntley irrigation project in Montana.

Messrs. David M. Duller and W. V. Burnell, of Houston, Tex., have organized the firm of Duller & Burnell, to conduct a general enginering business, with offices in the First National Bank Building, Houston. Mr. Duller has had a wide engineering experience and is especially qualified in the installation of power plants, chimneys and machiery, as well as garbage-disposal plants. Mr. Burnell until recently was County Engineer of Harris County, Texas, previous to which connection he served as Engineer and Superintendent of Construction for Stone & Webster. He has had considerable experience in electric-railway construction, water-works, street paving and various types of concrete construction.

OBITUARY

Prof. John Sweet, the oldest living past-President of the American Society of Mechanical Engineers, died at his home in Syracuse, N. Y., on May 8, at the age of 84.

William T. Wheeler, Secretary-Treasurer of the Port Jefferson (N. Y.) Electric Light Co., committed suicide on May 3 at the company's plant. It is understood that business troubles were the cause. Mr. Wheeler was 64 years old and lived in Port Jefferson.

Col. Albert E. Boone, a widely known railway builder and promoter of industrial and commercial enterprises, died at his home in Zanesville, Ohio, on May 3, at 71 years of age. He built the Ohio & Little Kanawa R.R. (originally the Zanesville & Ohio River Ry.) from Zanesville to Marietta, and the Zanesville Belt Line and Terminal Ry., connecting brick plants and outlying factories with the trunk-line railways entering Zanesville. He had lived in Zanesville for 35 years.

Lucien I. Blake, a well-known electrical engineer, died at the Boothby Hospital in Boston, Mass., on May 4. Professor Blake was born in Mansfield, Mass., in 1854 and graduated from Amherst College in 1878, after which he took the degree of doctor of philosophy, in Berlin. He was the inventor of a submarine signal and of an electrostatic ore separator. In making his experiments on the submarine signal he used the United States frigate "Constitution." Professor Blake was a brother of Percy M. Blake, Consulting Engineer, of Boston.

Frederick C. Kunz, Consulting and Bridge Engineer, Philadelphia, Penn., died on Wednesday evening, May 3, 1915, after a long period of ill health. Mr. Kunz was born in Austria 52 years ago and after completing his technical studies at the polytechnical school in Prague in 1886 he was for several years on the engineering staff of the Austrian Kaiser Ferdinand Nordbahn. Coming to the United States in 1891 he found employment with the Pencoyd Bridge Works in Philadelphia. The most important work on which he was engaged during his nine years' connection with the Pencoyd Bridge Works was the working up of the erection of the Niagara and Clifton arch bridges, both over the Niagara River. When in 1900 the company was absorbed by the American Bridge Co. he became Assistant to the Vice-President in charge of Enginering of that company, C. C. Schneider; he remained in this office until the summer of 1903. Mr. Kunz was appointed by Gustav Lindenthal, at that time Commissioner of Bridges of New York City, as Consulting Engineer of the Bridge Department, where he took an active and important part in the work of preparing specifications and plans for the Manhattan Bridge and the Queensboro Bridge. Early in 1904 he resigned to become the Chief Engineer of the Bridge Department of the Pennsylvania Steel Co. in Steelton, Penn., with whom he remained for several years. The most prominent work of which he had charge during this period was the construction of the Queensboro Bridge, on the safety of which he wrote a comprehensive report in 1908. Thereafter he established himself as consulting enginer, devoting a large part of his time to the writing of his work on "Design of Steel Bridges," one of the most comprehensive treatises on the subject in any language. Among his last construction work was the steel arch bridge at St. Johns, N. B., the plans for which were worked out jointly by the late C. C. Schneider and Mr. Kunz, who followed his friend to death within four months. Mr. Kunz' health had been poor for several years, and while his death came rather suddenly it was not altogether unexpected by his many friends, who sincerely mourn his demise.—O. H. Ammann.

Henry Floy, a consulting electrical and mechanical engineer, died suddenly at his home in New York City on May 5.

HENRY FLOY

Mr. Floy was born 50 years ago, at Elizabeth, N. J. He graduated from Wesleyan University in 1889 and then took a post-graduate course at Cornell University where he received the degree of M. E. in 1891 and the degree of A. M. in 1892. His first work was with the Westinghouse Electric Co. at Pittsburgh. After four years' service there he was transferred to the Chicago office as engineer and salesman, and a year later was put in charge of the office in Minneapolis. In 1898 he began practice as a consulting engineer in New York City in partnership with Prof. R. C. Carpenter of Cornell University. The partnership was dissolved three years later after which Mr. Floy practiced alone. His work was largely in connection with public utilities in the lighting and railway field. For several years he specialized in valuation work. In 1909 as the representative of B. J. Arnold, he had charge of the Bureau of Appraisal of the Public Service Commission of New York City, which was at that time engaged in appraising the properties of the street railways in greater New York and the elevated lines in Brooklyn. Mr. Floy was retained by municipalities as well as utility companies. In 1906 he made a report to the City of East Orange, N. J., on a proposed municipal electric-light plant; in 1907 he acted as arbitrator for the City of Colorado Springs on rates for public lighting. Mr. Floy was a Fellow of the American Institute of Electrical Engineers, and had served on its committees on Public Policy and on Appraisals and Valuation. He was also a Member of the American Institute of Consulting Engineers, the American Society of Civil Engineers, the Illuminating Engineering Society, the Engineers' Club, the City Club, and the University Club. At the Louisiana Purchase Exposition he served on the International Jury of Awards and was Chairman of the Committee on large electrical machinery. Mr. Floy was a frequent contributor to the technical press and to the proceedings of the societies of which he was a member. He was the author of treatises on the valuation of public-utility property and on high-tension underground electric cables.

ENGINEERING SOCIETIES

INTERNATIONAL RAILWAY FUEL ASSOCIATION.
May 15-18. Annual meeting at Hotel Sherman, Chicago. Secy., J. G. Crawford, 702 East 51st St., Chicago.

NATIONAL DISTRICT HEATING ASSOCIATION.
May 16-19. Eighth convention in New York City. Secy., D. L. Gasgill, Greenville, Ohio.

SOUTHWESTERN ELECTRICAL AND GAS ASSOCIATION.
May 17-20. Annual convention in Galveston, Tex. Secy., H. S. Cooper, Slaughter Building, Dallas, Tex.

NATIONAL ELECTRIC LIGHT ASSOCIATION.
May 22-26. Convention in Chicago. Secy., T. C. Martin, 29 W. 39th St., New York City.

MASTER BOILER MAKERS' ASSOCIATION.
May 23-26. Annual meeting in Cleveland. Secy., H. D. Vought, 95 Liberty St., New York City.

AMERICAN IRON AND STEEL INSTITUTE.
May 26-27. General meeting in New York City. Secy., J. T. McCleary, 61 Broadway, New York City.

NATIONAL CONFERENCE ON CITY PLANNING.
June 5-7. Conference in Cleveland. Secy., Flavel Shurtleff, 19 Congress St., Boston, Mass.

AMERICAN WATER-WORKS ASSOCIATION.
June 5-9. Convention in New York City. Secy., J. M. Diven, 47 State St., Troy, N. Y.

MASTER CAR BUILDERS' ASSOCIATION.
Annual meeting, Atlantic City, N. J., June 14-16, 1916. Secy., Jos. W. Taylor, Karpen Bldg., Chicago.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
June 14-17. Eighth semiannual meeting. Cleveland. Secy., I. C. Olsen, Cooper Union, New York City.

SOCIETY OF RAILWAY CLUB SECRETARIES.
June 16-17. Annual meeting in Atlantic City. Secy., H. D. Vought, 95 Liberty St., New York City.

AMERICAN RAILWAY MASTER MECHANICS ASSOCIATION.
Annual meeting, Atlantic City, N. J., June 19-21, 1916. Secy., Jos. W. Taylor, Karpen Bldg., Chicago.

TRI-STATE WATER AND LIGHT ASSOCIATION OF THE CAROLINAS AND GEORGIA.
June 21-23. Annual convention at Isle of Pines, S. C. Secy., W. F. Stieglitz, Columbia, S. C.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 27-30. Annual meeting in Pittsburgh. Secy., Charles Warren Hunt, 220 West 57th St., New York City.

AMERICAN SOCIETY FOR TESTING MATERIALS.
June 27-30. Annual meeting in Atlantic City. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia, Penn.

The Intermountain Good Roads Association will hold its annual meeting June 13 to 14 in Ogden, Utah. The secretary is T. H. Burton, Nephi, Utah.

The Engineering Society of Buffalo held its final meeting of the season on the night of May 3 at the Hotel Statler. About 200 members were present. The membership of the society has grown to 450 and it is claimed that the average attendance at the meetings during the winter was 200. At the last meeting the existing officers were reëlected and include President John Younger; vice-presidents, W. A. James and Jesse G. Melendy; treasurer, William Dollar; and secretary, W. J. Gamble, 247 Rano St., Buffalo, N. Y.

The Detroit Engineering Society held its 22nd annual banquet on Saturday, Apr. 15, at the Hotel Statler, about 460 members being present. The speakers were Mayor Oscar C. Marx, whose subject was "The Relationship of Engineers To the City," Edgar A. Guest, of the Detroit Free Press, and Henry A. Wise Wood, of New York. At a business meeting held just prior to the banquet, the following officers were elected: President, Horace H. Lane; vice-presidents, William Pitt Putnam and L. R. Hoffman; secretary, D. V. Williamson, 46 Grand River Avenue W., Detroit, Mich.

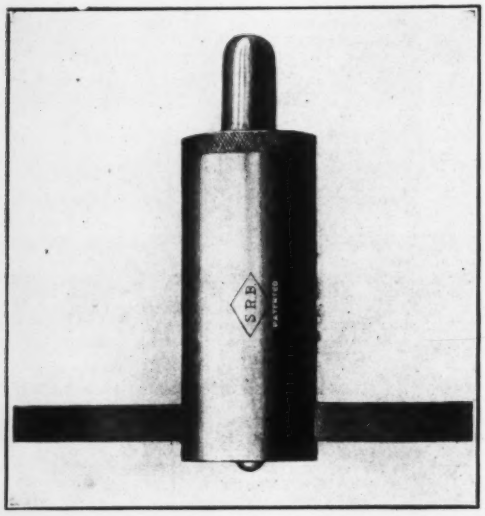
The American Water-Works Association holds its 36th annual convention in New York City, June 5 to 9. June 8 will be known as "Superintendents' Day," and will be devoted to answering questions proposed in advance, asking questions, exchange of experiences and short papers or talks on practical questions of interest to water-works superintendents. One of the questions to be discussed at this session is that of private fire services, their limits and the responsibility they entail upon the water-works company. Other interesting items will be experiences with fish in mains and methods of removing them, experiences with frogs in reservoirs, with pipe-locating and leak-finding devices, with purchase of supplies and materials for competitive bids, with strength of lead pipe, with electrolysis, and with cleaning sand, gravel or mud from mains. The secretary is J. M. Diven, 47 State St., Troy, N. Y.

Appliances and Materials

Portable Brinell-Test Outfit

A portable outfit for making the Brinell hardness test on metals, which weighs only 6½ lb. and goes into a 9¼x6¼x4-in. carrying case, is being sold by H. A. Holz, 50 Church St., New York City. It is not necessary to cut a specimen from the piece whose hardness it is desired to measure, and it is possible to test thinner sheets than practicable in the regular Brinell machine.

The portable tester is very simple, as may be seen from the accompanying illustration. There is a hollow cylindrical body having a longitudinal hole for a free plunger and a



PORTABLE BRINELL HARDNESS-TEST DEVICE

transverse hole for a standard square comparison bar. The plunger rests on the test bar and a 10-mm. steel ball is held loosely in contact underneath. With the apparatus assembled as shown, the ball is placed on the spot to be tested and the plunger is hit with a 3-lb. hammer. The depressions in the standard and unknown piece are calipered by transparent diverging-line gages. The hardness of the unknown piece is related to that of the standard by the inverse ratio of the squares of their widths of depressions.

The outfit complete comprises, besides the socket and plunger, a dozen 10-mm. standard balls, six standard comparison bars, two caliper scales, a set of direct-reading tables and a key for inserting new balls.

* * *

Automatic Penetrometer

An automatic electrically controlled penetrometer for testing asphalts, etc., has been developed by Howard & Morse, laboratory-instrument makers, 1197 De Kalb Ave., Brooklyn, N. Y. It is claimed that this instrument eliminates personal equation from the penetration determinations. The device comprises a stand, with rising table for the specimen, and an upright supporting the loaded needle, penetration scale and timing clock. The clock is set to stop the needle in 1, 5 or 60 sec. In making a test the current is first turned on to hold the needle; then the asphalt sample is adjusted to the needle, using the rising table and a mirror. The clock is next set for the interval desired and the recording rack and dial set on the needle bar. The circuit is opened by pulling a chain, and the clock closes the circuit at the desired time, stopping the needle.

* * *

Galvanized Metal-Flume Fittings

The R. Hardesty Co., Denver, Colo., manufacturer of the Hess, McGinnis and Lennon types of metal flumes, is now placing on the market flumes with galvanized-iron fittings throughout—rods, bars and accessories.

It has been customary since patent jointed metal flumes came into use a dozen or more years ago to use, at the joints, bars and rods that have been dipped in black paint or hot asphalt. This practice has continued in spite of the fact that specifications covering the galvanizing and protecting of the flume plates from corrosion have been growing more rigid. It has been found by experience that former methods of protecting the rods and ribs forming the joints are insufficient and are often responsible for the corrosion of the sheets. It is claimed that the zinc coating on the sheet surrounding the unprotected iron rod is thrown into solution by electrolytic action and is deposited on the rod or bar, leaving the flume sheet unprotected and subject to corrosion. The use of these galvanized fittings adds about 10% to the cost of the flume (exclusive of substructure).

* * *

Small Mixer Equipped with Silo Hoist

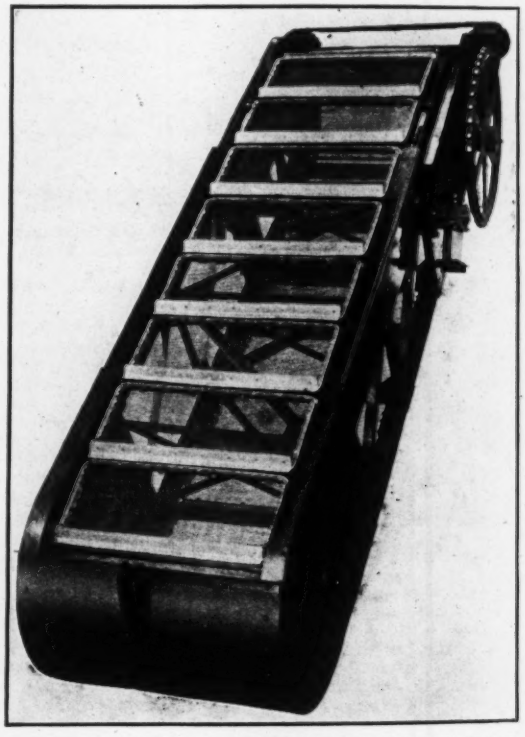
The small concrete mixers ("Rex 6") of the Chain Belt Co., Milwaukee, Wis., are now furnished with a hoist for elevating buckets of concrete. This arrangement was developed especially for silo building. The hoist is located on the main countershaft of the mixer. It will operate with 100 ft. of ⅝-in. manila rope, 155 ft. of ½-in. rope, 280 ft. of ⅜-in., 400 ft. of 5/16-in. and 650 ft. of ¼-in. wire cable. The average hoisting speed is 350 ft. per min. (single line). The hoist will lift 100 lb. with a 3-hp. engine when the mixer is loaded and 300 lb. empty. The "Rex 6" has capacity for 6 cu.ft. of loose material or 4 ft. of mixed concrete per batch and costs $300. The price includes loading platform, but the power loader and water tank cost extra.

* * *

Traveling Intake Screens

Traveling screens for cleaning circulating and boiler water in power plants have been successfully employed for several years. The use of such screens, however, is outgrowing the central-station field. The Chain Belt Co., of Milwaukee, Wis., now builds them in standardized designs for any service requiring water free from the larger foreign particles.

The machines consist essentially of wire screening baskets mounted on two parallel steel-chain belts driven by a 3-hp. motor. The apron thus formed passes over sprockets at the top and bottom of the device, the sprockets being mounted on



TRAVELING WATER SCREEN MANUFACTURED BY THE CHAIN BELT CO

a supporting frame. Ordinarily the screens are placed on an incline, but they can be built to operate in vertical position, as was the case in the Commerce St. plant of the Milwaukee Electric Railway and Light Co. The particles screened from the water are carried upward on lips formed on the baskets. After turning over the head sprockets the particles fall into a trough, from which they are flushed out. The cleaning of the screen baskets after they pass over the head sprockets is accomplished by spraying from the back side.

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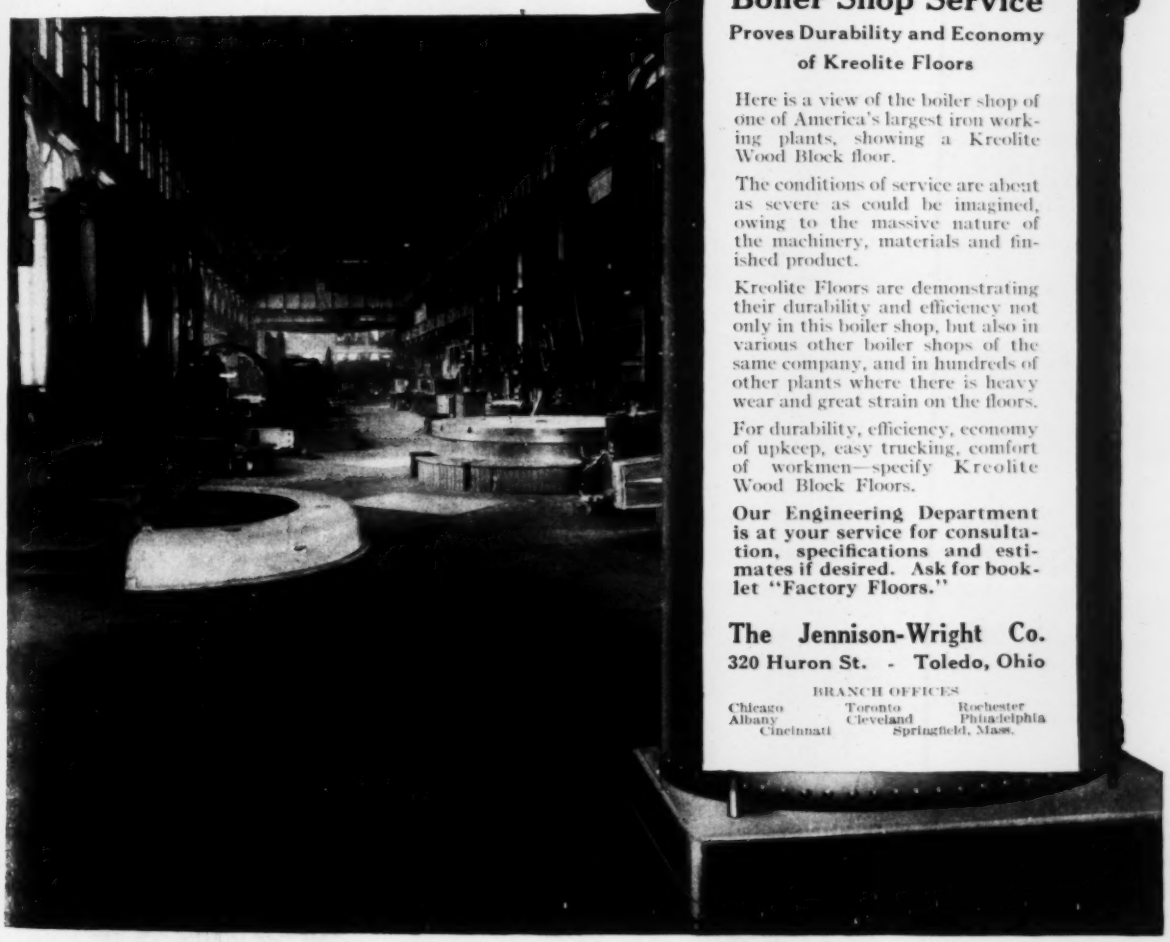
KREOLITE
WOOD BLOCK
FLOORS



Boiler Shop Service

Proves Durability and Economy of Kreolite Floors

Here is a view of the boiler shop of one of America's largest iron working plants, showing a Kreolite Wood Block floor.

The conditions of service are about as severe as could be imagined, owing to the massive nature of the machinery, materials and finished product.

Kreolite Floors are demonstrating their durability and efficiency not only in this boiler shop, but also in various other boiler shops of the same company, and in hundreds of other plants where there is heavy wear and great strain on the floors.

For durability, efficiency, economy of upkeep, easy trucking, comfort of workmen—specify Kreolite Wood Block Floors.

Our Engineering Department is at your service for consultation, specifications and estimates if desired. Ask for booklet "Factory Floors."

The Jennison-Wright Co.
320 Huron St. - Toledo, Ohio

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"SINCE USING LACKAWANNA STEEL SHEET PILING OUR CONSTRUCTION TROUBLES HAVE BEEN REDUCED WONDERFULLY"

The contractor (name on request) who made the above statement concerning cofferdam work from 18 to 26 feet below water also told us:

"We have noted particularly the great resisting powers of the Lackawanna interlock under outside pressure and how in tightening, the joint becomes watertight. After the slack has all been taken up, we have found in removing shoring, that the steel sheet piling has wonderful supporting power within itself. With ordinary care in bracing and shoring, there is absolutely no danger of a Lackawanna Steel Sheet Piling cofferdam collapsing where properly driven.

"We also find a great saving in the amount of shoring timber required, owing to this greater sustaining power of the steel walls. This facilitates excavation by having more room between braces and makes the driving of foundation bearing piles easier. We also find little difficulty in pulling Lackawanna Steel Sheet Piling after concrete is placed."

Hundreds of similar letters in our files indicate that Lackawanna Steel Sheet Piling invariably makes staunch friends and fully meets every claim.

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For Great Britain and British Colonies in the Eastern Hemisphere, Cargo-Fleet-Iron Co., Ltd., Middlesborough, England. For France, Italy, Spain, French Colonies and Protectorates, Italian Colonies and Spanish Colonies in the Eastern Hemisphere: Cie Des Forges & Aciéries de la Marine et d'Homécourt, Paris, France.

Engineering News

VOLUME 75 MAY 18, 1916 NUMBER 20

Rapid Tunneling in Brazil

By J. C. Balcomb*

SYNOPSIS—A 5¼-mi. tunnel was built at top speed to bring water to the Lages reservoir of the Rio de Janeiro Tramway, Light and Power Co. A length of 27,657 ft. was completed in 489 days; the best single-face monthly record was 512 ft. A large advance heading, 13x8 ft., was driven. Five drills were mounted on a horizontal column and moved with a tunnel carriage. Mucking and drilling went on together. Twenty holes were shot in rotation by using varying lengths of fuse. Bonus system of wages helped speed; Spanish labor preferred to native or North American.

Pirahy tunnel in Brazil for years will be a topic of live engineering interest, both because of its construction and its use. Its 27,657 ft. of length was finished from portal to portal in 489 days, and the best single-face monthly record was 512 ft. Conditions at all times were subordinated to speed, and this brought unusual handling of labor and equipment.

The City of Rio de Janeiro, with a population of over 1,000,000, is supplied with all electricity for light, power and city transportation by the Rio de Janeiro Tramway, Light and Power Co., Ltd., a Canadian corporation. The principal power-generating station is located about 50 mi. west of the city, at Lages, and is designed for a maximum output of 50,000 kw. This is a hydro-electric plant, operating under a 1,000-ft. head (see *Engineering News*, July 17, 1913) and drawing its water-supply from a reservoir of some 6,777,600,000-cu.ft. available capacity.

The project was constructed during the comparatively wet years of 1905-07, and there never was any shortage of water apparent until about 1910. Then, owing to the unprecedented demand for electricity in the city and to a succession of dry years, the water level in the reservoir became very low, and an auxiliary steam plant had to be built in Rio de Janeiro. As the coal bill to operate this amounted to several thousand dollars per day, some additional water-supply became imperative, and the 5¼-mi. Pirahy tunnel was designed and bored to divert the water of the Pirahy River into the Lages storage reservoir. Since the completion of this tunnel not a pound of coal has been consumed at the steam plant.

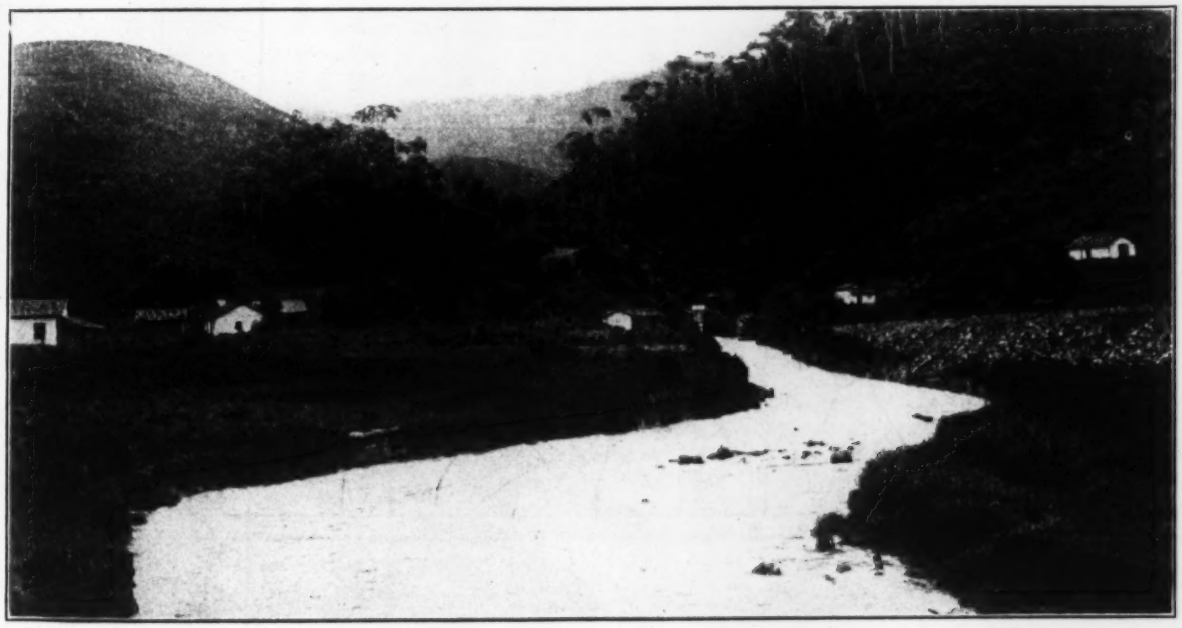

FIG. 1. DISCHARGE FROM PIRAHY TUNNEL, LAGES POWER DEVELOPMENT, BRAZIL

The tunnel was bored under three hills, as shown on the accompanying profile, the two end elevations being divides and the center one a round knob. The work was attacked at ten faces by means of four shafts and two portals. One shaft was located very close to the outlet end; therefore, the progress was actually made from eight working faces.

*Pearson Engineering Corporation, 115 Broadway, New York City.

Construction began on approach cuts Nov. 1, 1911, and water was turned into the tunnel on Sept. 28, 1913, an interval of not quite 23 months. The advance heading, 13 ft. wide by 8 ft. high, was probably one of the largest ever driven. It was justified by the expectation that water would be demanded as soon as the headings met, so that as great an area as possible was desirable, and it was so planned that stoping might be delayed until the demand for water was less urgent. For speed the Swiss system of tunneling in hard rock was adopted—namely, a bottom heading and short rounds thrown well back from the face with plenty of powder in order to facilitate mucking. The times of the several tunneling operations are shown by Table 1.

The rock in about 90% of the tunnel was solid gray gneiss of constantly changing character and very seamy and fractious; the rest of the material was either decomposed trap, necessitating timbering, or strata of extremely hard diabase. Only about 1,000 ft. of the tunnel had to be lined. Water was struck in every advance, and pumps were maintained at all shafts and the upper portal end.

Five Ingersoll-Rand 3¼-in. piston drills were used in each face, and it was the endeavor to supply them with air at 95 to 105 lb. The first bit was a 2⅝-in., the second 2⅛-in., the third 1⅞-in., the fourth 1⅝. The powder sticks were 1¼x7 in. A great deal of time was lost on account of inability to get spare parts, and the full economy of the machines was seldom realized. These five drills were supported on an 8-in. horizontal column 12 ft. long, which in turn was taken to and removed from the face by a Carter tunnel carriage. This apparatus consists of a small truck supporting a beam that projects to the front over the pile of muck, and a mechanism to propel the 8-in. horizontal column back and forth along the beam. After a blast the track was cleared of debris to within about 16 ft. of the face, the carriage was pushed forward as far as possible and the head end of the beam blocked up on the muck pile. The horizontal column that supported the five machines was then run forward to within about 4 ft. of the face and there jacked securely to the sidewalls. When firmly in position, it was released from the beam, and the carriage was taken back into the tunnel and stored on a spur track, where it remained out of the way until drilling was completed.

TABLE 1. TIME OF PIRAHY TUNNELING OPERATIONS

General Averages of Faces, Based on 7 Months' Progress

Setting up drills (including "barring down" roof, cleaning track, blocking column and time lost for smoke)	1 hr. 13 min.
Drilling	4 hr. 10 min.
Taking down drills	20 min.
Blasting (including loading)	8 min.
Average time between shots	7 hr. 11 min.

The number of men actually employed at the working face averaged about as follows: 1 face foreman, 1 muck foreman, 6 drill runners, 6 drill helpers, 22 muckers, 1 extra drill runner and helper to insure full service of machines every shift. Muckers include car pushers and laborers pulling back rock from face. Labor mostly Spanish; three 8-hr. working shifts.

Averages Based on Best Week's Work (Pinheiro, Apr. 16-22)

Setting up drills (including "barring down" roof, cleaning track, blocking column and time lost for smoke)	1 hr. 8 min.
Drilling	3 hr. 46 min.
Taking down drills	14 min.
Blasting (including loading)	33 min.
Number of holes	20
Depth of holes	1.5 m.
Dynamite, 92% blasting gelatin	99 sticks
Dynamite, 62% gelignite	138 sticks
Average time between shots	5 hr. 41 min.
Total advance (7 days 2½ hr.)	41 m. = 134½ ft.
Average daily advance	5.77 m. = 18.85 ft.
Average advance per shot	1.37 m. = 4.49 ft.
Number of blasts in week	30
Dynamite per cubic meter	8.4 lb. = 6.48 lb. per cu.yd.
Material	Uniform gray gneiss, flat roof—no timber

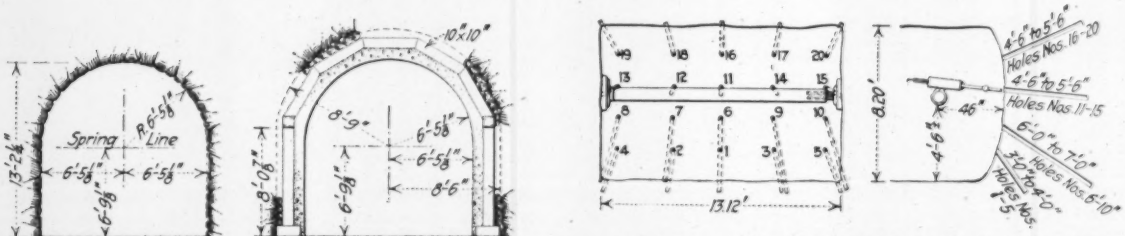

FIG. 3. DIAGRAM SHOWING ADVANCE METHOD
Holes usually fired in rotation shown by numbers

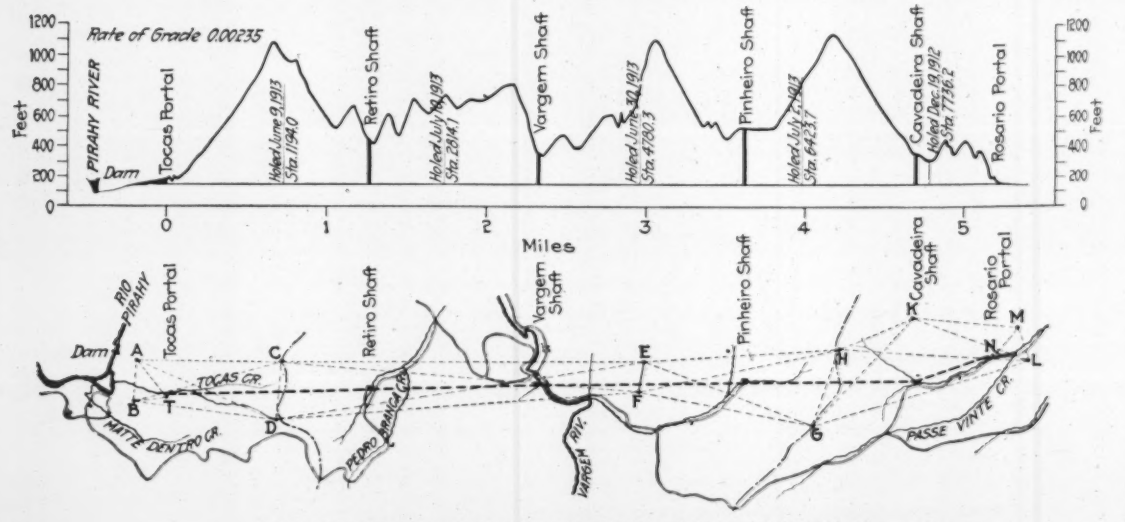

FIG. 2. PLAN, PROFILE AND SECTIONS OF PIRAHY TUNNEL

FIG. 4. INTERIOR OF PIRAHY TUNNEL

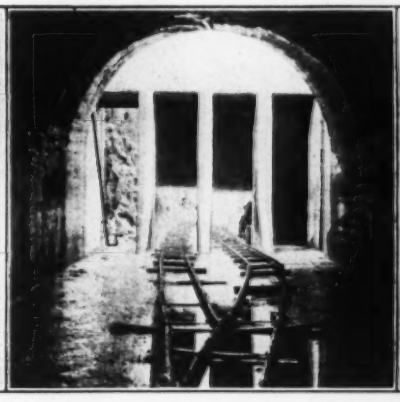

FIG. 5. TUNNEL AT INLET GATES

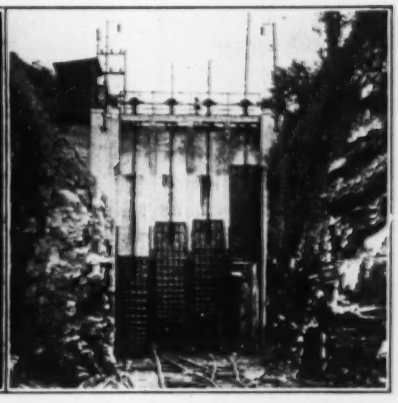

FIG. 6. TUNNEL ENTRANCE AND GATES

The advantages derived from the use of the tunnel carriage were that it saved the time necessary to muck back from the face for vertical columns; it saved the men the heavy lifting and tugging of the drills and vertical columns over the muck; and it gave the muckers a clear space to muck out under the column, as the drill runners could stand upon it to crank their machines. The method of drilling, the depth and position of drill holes and the rotation of shooting are shown in Fig. 3.

Unusual Blasting Methods

After the completion of drilling, the holes were cleaned with compressed air by a nozzle on the air hose and afterward nearly filled with gelignite, or blasting gelatin, ranging in strength from 62% to 92%. Very little tamping was done other than stuffing in a few pieces of dampened cardboard that came wrapped around the powder. Only the very highest grade of fuse, every foot of which was guaranteed by the manufacturers to be X-rayed, was used; this was cut into equal lengths and properly prepared with detonators, etc., above ground. (No. 8 detonators were used exclusively after numerous failures with No. 4 and No. 6.)

When the holes were all loaded and the fuse tamped in, the round was made ready to fire in the following manner: The five top fuses in holes Nos. 16 to 20 inclusive (Fig. 3) were left full length; beginning with No. 15 a short length was cut off, and the length of the piece thus cut was gradually increased in each succeeding hole until the first hole to be shot (No. 1) remained with the shortest fuse. A foreman would then peel back the paper on a stick of gelignite, ignite it and use it to "spit" the fuses, beginning with hole No. 1 and finishing with any one of the top holes.

The deliberation with which the Spanish foremen performed this task was almost uncanny; but it was very successful, as it left a distinct interval between each shot and the workmen soon learned to locate the missed hole accurately by a too long lapse of time. A second shot to clear away a bump left by a missed fire was rarely necessary; it usually saved much time to wait and remove these later with Jackhamers and light shots from behind. The men became expert at this style of shooting, and a great deal of the speed attained was attributable to the system. Such a method is contrary to almost any state law in the United States as being too dangerous, but its justification in this case lies in the fact that in the thousands of rounds fired by this method on the Pirahy tunnel there was not a single accident from that cause. After the round had been fired and a reasonable time had been allowed for any missed shots (but without waiting for smoke to clear), the machine runners and helpers went in to bar down the roof and clear the face, while the muckers followed and cleared the track for the tunnel carriage.

As in most tunnels, the progress was limited principally by the ability to get the muck out of the way. To hasten this work, the double-shift system was used. The muck car was brought in by car pushers, and the box was thrown to one side of the track and the truck to the other, a little way back of the face. The resting shift kept an eye on the loaders at the front, and when their car was nearly full, the former got ready to throw truck and car body on the track as soon as the loaded car was pushed by. Very little time thus elapsed when cars were not being actually loaded.

During a record week, cars were loaded and taken out at the rate of a car every 4 min.; the general average under fair conditions was about 6½ to 7 min. to each. Under ordinary circumstances it was found that by keeping plenty of men to rake back the muck from the front and under the column the muckers could get the material out of the way and do all necessary track laying as soon as the drilling was finished and be ready to help the machinemen take down the column, etc. The speed attained by using the foregoing method of drilling, shooting and mucking is shown in Table 2 on p. 925.

Bonus System of Wages

To encourage the men to take a personal interest in the progress, a unique bonus system was adopted. A minimum month's work was made 75 lin.m., and the bonus began above that figure; for every meter in excess of 75 m. and up to 90 m. the men were given 75 milreis, or about $24.20, per lineal meter. For everything over 90 m. a month, 150 milreis, or about $48.40, per meter was granted. In the record month there was distributed something over $3,550 among 135 men at one face. This bonus was distributed to the men in proportion to the wages received by them at the end of the month. All men known as "smoke eaters," who actually did the hard and sometimes dangerous work at the face, participated in this bonus in proportion to the full amount of their wages; other men helping the progress more indirectly, such as car pushers, cage tenders, steel sharpeners, etc., shared in the bonus in a proportion of from one-quarter to one-half of their wages, the idea being not only to make it an object for the best men to strive to get to the most

essential part of the work, but to keep all men interested in the progress. Probably one of the greatest advantages of this bonus was that it automatically kept the gangs at a minimum number—the more men the less bonus to each and *vice versa*. Also, the men themselves made it convenient for a loafer to quit.

This bonus system worked splendidly throughout the job, and more than any other one thing it was responsible for the great progress made. The disadvantage of this plan, as of any other bonus system, was that it tended to make the men careless, safety and all other considerations being neglected to gain a few meters. The foremen in all instances had to see personally that the men barred down the roof properly and took no unnecessary chances.

Labor and Cost Data

During the first eight months or more of the work it was endeavored to do the heavy labor with native Brazilians. This idea, however, had to be abandoned, as the natives had not the inclination, the strength or the intelligence to work as hard and steadily as was required. Even the inducement of higher wages than ever before paid in that country failed to attract any men who could run drills or do ordinary tunnel work, until foreigners (principally Spaniards, but with some Portuguese and Italians) were finally secured. If comparisons are made with other tunnel records, it should be borne in mind that on the Pirahy tunnel all men were green hands when hired; all machine runners, helpers, muckers, powdermen, tool sharpeners, etc., learned the business on the job. It is reasonable to assume that, had this organization on the completion of this tunnel been shifted to another and similar piece of work, the progress would have been considerably more rapid. While the natives made poor tunnel labor, fair blacksmiths, mechanics and roustabouts were recruited from among them. The organization built up gradually became as fine a body of laborers as the writer has ever seen in any country. The wages paid averaged about as follows:

Face foremen		$3.26 for 8 hr.
Muck bosses		2.90 for 8 hr.
Machine runners	2.26 to	2.43 for 8 hr.
Machine helpers	1.80 to	1.94 for 8 hr.
Muckers	1.45 to	1.80 for 8 hr.
Other inside labor	1.29 to	1.45 for 8 hr.
Timbermen	1.60 to	2.60 for 10 hr.
Blacksmiths	2.60 to	3.26 for 12 hr.
Blacksmiths' helpers	1.45 to	1.94 for 12 hr.
Mechanics	1.45 to	2.42 for 10 hr.
Roustabouts	.97 to	1.29 for 10 hr.

These wages, except for roustabouts, are probably 25% higher than the average paid in that country. Men were paid with Brazilian milreis, and the wage list given is calculated with exchange at $3\frac{1}{10}$ milreis to the dollar, the average rate before the war.

Advance (based on a seven months' average period):

	Per Cu.M.	Per Cu.Yd.
Labor	$7.77	$5.92
Bonus	.97	.74
Powder* and fuse	3.11	2.37
Total	$11.85	$9.03

Stoping (based on progress of August, 1913):

	Per Cu.M.	Per Cu.Yd.
Labor	$4.21	$3.21
Bonus	1.05	.80
Powder† and fuse	1.35	1.03
Total	$6.61	$5.04

*Powder used in advance, 9.04 lb. per cu.m. and 6.90 lb. per cu.yd. †Powder used in stoping, 4.49 lb. per cu.m. and 3.43 lb. per cu.yd.

The cost of labor (actually employed in tunneling operations), powder and bonus, per cubic yard of tunneling in hard rock, was about as shown above (powder—of English manufacture—cost, laid down on the work about 30c. per pound). If economy, rather than mere speed, had been of prime importance, the figures herewith could have been shaded a third or more.

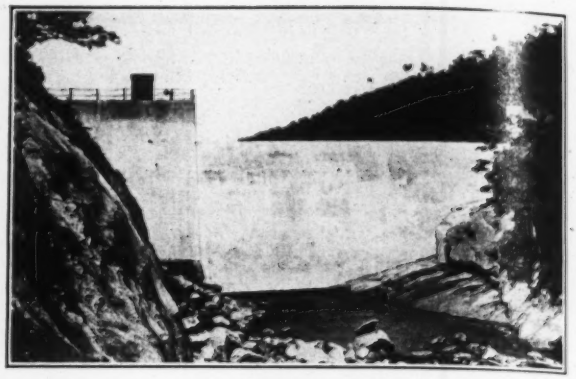

FIG. 7. PIRAHY DAM FROM DOWNSTREAM SIDE.

It may be interesting to mention here that 200 tunnel laborers and their foremen from the New York subway work were sent down to the Pirahy tunnel to show the Spaniards "how to do it." Most of the Americans turned round and went back north on the same boat that they arrived on. The few who remained were disinclined to work with the horizontal column and preferred the vertical-column method, where the face must be cleared first, losing much time thereby; they refused to use any but electric exploders in blasting and would not go into the smoke like the Spaniards. Furthermore, the American machine runners would not help muck back and assist the progress, as did the Spanish machine runners. This experiment decided for us, at any rate, that American laborers cannot or will not successfully put up with labor conditions as they are met with in Brazil.

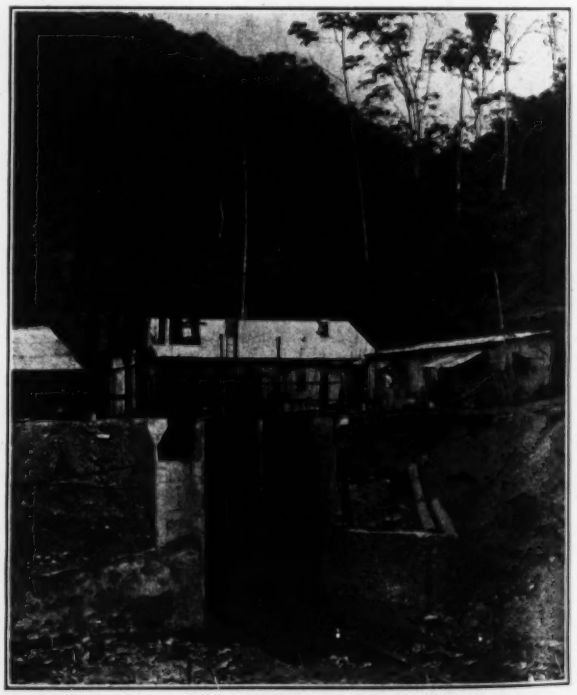

FIG. 8. VARGEM SHAFT INLET, PIRAHY TUNNEL

After the headings had all met and water had been allowed to run through the tunnel for a few days, it was endeavored to stope during 10 hr. in the daytime and permit the water to run through at night. It was speedily discovered, however, that this was impracticable, as it took several hours for the tunnel to drain, and the proportion of lost time was out of reason. Therefore, the whole force was put to stoping 24 hr. a day, using telescopic

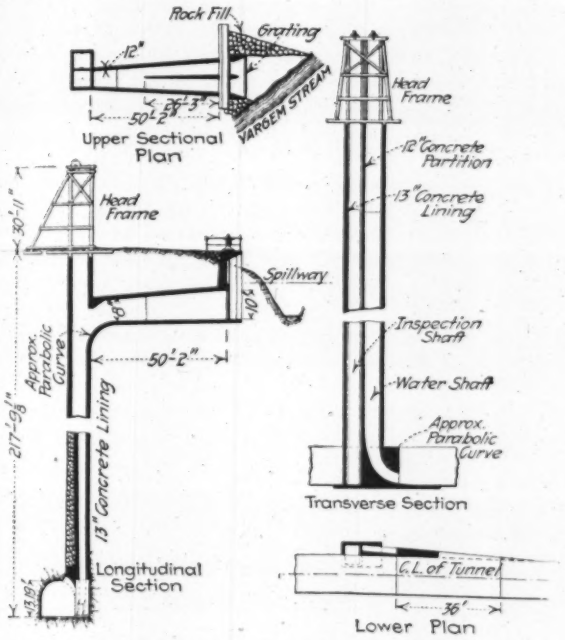

FIG. 9. "SNOUT" DIVERTING VARGEM RIVER INTO PIRAHY TUNNEL

drills for stoping, jackhamers for trimming and 52% gelignite for blasting; the record made is shown in Table 1.

When any timbering was necessary, it was found desirable and economical to import timber for that purpose from the United States. The native lumber was principally hardwood, extremely difficult to tool and too heavy to handle economically, particularly in segment work. The Parana pine from southern Brazil was too brash and totally unfit to withstand any great stress. Therefore, practically all timbering except lagging was done with North American pine.

The country under which the tunnel passes is very broken, and the triangulation system adopted embraced some unique features. No suitable place for a long base line existed except in the bottom of a valley, and to utilize such a location and transfer the measurements to the hilltops involved a secondary triangulation system of no mean proportions. For that reason the base line chosen was put a-straddle of the center hill under which the tunnel passes. This hill is a high round knob, and it afforded room for only a 320-m. base line. Even with this length the two ends were separated by the summit of the hill and invisible from each other. It was accurately measured by the common method of chaining on the slope, taking temperatures and reducing to 60° F. and afterward reducing to the horizontal by means of precise leveling. In one quadrilateral the ends were 320.2 m. and 596.4 m. long, and the sides were 2,682.5 m. and 3,688.2 m. long, while two of the included angles were only 4° 42′ and 4° 58′—proportions which are contrary to the accepted standards of good triangulation. All quadrilaterals were adjusted by an approximation of the method of least squares according to Johnson, and the results were entirely satisfactory.

The greatest chaining difference between any two shafts was 0.66 ft. in a distance of 6,839 ft., and the chaining underground was never checked, it not being considered necessary. The center line overhead was first projected from the triangulation system, which gave the line very close to its correct position; this was afterward trued by repeated plungings of the transit. One shot along this line was over 7,000 ft. long. Had shorter distances been adopted, it would have meant probably 10 or 12 shots instead of one, on account of the broken country; and it was figured that the 10 or 12 shots would introduce a greater aggregate error than the long shot, if it were carefully made under favorable light and weather conditions. This line was transferred to the tunnel below by means of 10-kilo (22-lb.) plumb bobs suspended on piano wire about 11 ft. apart, and the engineers were allowed only one 8-hr. shift at each shaft to perform this work. Every precaution was taken during that short time, and the results attained were very accurate. The maximum miss in alignment was 0.160 ft. and in level 0.181 ft. It was found necessary to use American engineers for any work requiring real skill and some initiative; the European engineers encountered in the country and the native Brazilian engineers were not satisfactory except on ordinary instrument work.

TABLE 2. RECORD OF ENGINEERING CHECKS AND LABOR PERFORMANCES, PIRAHY TUNNEL

From Shaft or Portal	Engineering: Distance in Ft., C. to C. of Shafts, or Portal to Shaft, Computed	Chained	Differences	Alignment Missed in Ft.	Levels Missed in Ft.	Labor on Advance*: Distance Each Way from Shaft, Ft.	Actual Working Days	Average Advance per Working Day, Lin. Ft.	Greatest Progress, Single Month Distance, Ft.	Average per Day, Ft.	Labor Performance—Stope†: Distance Each Way from Shaft, Ft.	Total Actual Working Days	Average Stoping per Working Day, Lin. Ft.	Greatest Progress, Single Month Distance, Ft.	Average per Day, Ft.
Tocas	6,687,903	6,688,043	+0.141	0.026	0.043	3,917.3	469.4	8.34	397.7	12.8	3,917.2	96.1	40.7	1,476.4	47.6
Retiro up						2,770.7	325.9	8.50	396.6	13.2	2,770.7	98.1	28.2	1,207.3	39.0
Retiro down	5,650,225	5,650,277	+0.052	0.160	0.038	2,544.6	356.9	7.13	341.2	11.0	2,570.5	61.9	41.5	1,558.4	50.2
Vargem up						3,105.6	365.5	8.50	389.8	13.0	3,079.7	68.1	45.2	1,269.7	41.0
Vargem down	6,839,585	6,838,922	—0.663	0.071	0.003	3,345.1	354.8	9.48	438.0	14.6	3,337.6	77.9	42.8	1,348.4	43.6
Pinheiro up						3,494.4	277.3	12.61	512.5	17.1	3,502.0	57.1	61.4	1,706.0	55.1
Pinheiro down	5,728,222	5,727,001	—1.221	0.019	0.016	1,897.3	249.3	7.61	366.5	11.8	2,698.7	76.1	35.4	856.3	27.6
Cavadeira up						3,831.0	291.7	13.13	504.9	16.3	3,029.5	68.0	44.5	1,532.2	49.5
Cavadeira down	2,751,238	2,751,003	—0.235	0.127	0.081	474.7	30.2	15.7	284.1	15.0	188.8	14.7	12.8	188.6	....
Rosario						2,276.2	289.7	7.86	332.0	11.0	2,562.4	136.0	18.8	511.8	16.4
Totals	27,657,174	27,655,248	—1.927												

* General average, based on actual working days, 9.87 ft. per day. Averages are for each face per day. Greatest single month's record for entire tunnel, April, 1913, 3,133.2 ft. Daily average, 104.3 ft.; this record made from eight working faces. † General average, based on actual working days, 37.04 ft. per day. Averages are for each face per day. Greatest single month's record for entire tunnel, August, 1913, 10,430 ft.; 26 working days—water through for five days—daily average, 401.2 ft.

On completion of the tunnel the engineering department conducted an extensive series of water measurements to determine its capacity. For preliminary estimates of tunnel flow an n value in Kutter's formula of 0.02 had been adopted. Subsequent measurements demonstrated this figure to be much too low, and a value of about 0.03 was determined to be more nearly correct. This would probably prove true in any other unlined tunnel dug in similar rock and of comparatively similar slope and cross-section.

The measurements to determine the flow of water in the tunnel were very careful and quite elaborate, and several measuring instruments were used to check against each other, among them two current meters—one acoustic and one electric—and a pitot tube. Also, to get the velocity of the water through the tunnel, a quantity of aniline dye was thrown in at the inlet end and a note made of the time required for the colored water to pass through the tunnel. Experiments were conducted at the

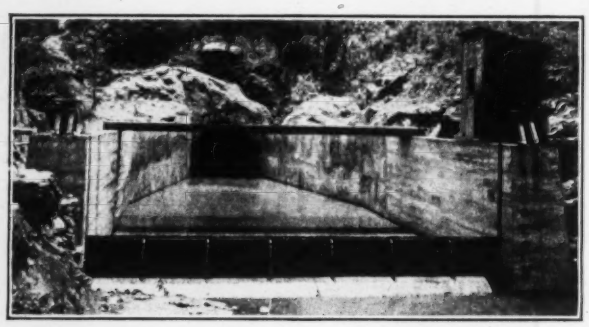

FIG. 10. WEIR AT OUTLET OF PIRAHY TUNNEL

outlet of the tunnel with a salt titration process to determine the flow, but the amount of salt required rendered it impracticable. Finally, a sharp-crested rectangular weir was built just below the outlet of the tunnel, and by means of a recording float gage an accurate record of the tunnel flow was maintained. The n value of 0.03 was deduced from these various measurements.

Allied Works of Pirahy Tunnel

Across the Pirahy River near the inlet of the tunnel was built a concrete dam of the overflow gravity type. This dam was for diversion only, and the construction involved no unusual difficulties except the ever-present problem of transportation of materials in such a country. It impounded practically no storage water. The flow into the tunnel was controlled by four electrically operated rectangular valve gates each 5x16 ft. These are closed only at rare intervals, when inspection of the tunnel is considered necessary.

About midway of the tunnel and traversing the surface is a small stream called the Vargem River. As there was a shaft at this point, it was decided to utilize this water for storage by diverting it into the tunnel by way of the shaft. It is obvious that, were this water dropped perpendicularly down the shaft, the disturbance created at the bottom would have a retarding effect on the main stream passing; it is equally apparent that if the force of water dropping 200 ft. was properly directed and the force expended in the right direction, it should have an accelerating effect upon the main current of water in the tunnel. So with this in view the water from the Vargem was guided into the tunnel at the foot of the shaft by a reinforced-concrete tube colloquially known as the "snout." This was so constructed (Fig. 9) that the falling water was diverted from a vertical to a horizontal flow down the tunnel by an approximate parabolic curve and at the same time thrown sidewise enough to enter the main stream at a small angle (the shaft proper being situated at the side of the tunnel).

It was almost impossible to make any actual observations or calculations of the effect of the entrance of this water at the foot of the shaft, but it was discovered that it was an extremely hard matter to build a floor there which would withstand the heavy impact of the falling water. The writer had himself lowered with ropes into the tunnel stream one time and observed the action for some minutes, and from these and subsequent observations it is believed that the falling water actually assists the velocity of the main stream to some extent when the tunnel is running full, as there is no apparent disturbance. When running only half full, the commotion is so great that there must be some slight retardation.

The tunnel was constructed by administration by the Rio de Janeiro Tramway, Light and Power Co., Ltd., of which W. G. McConnel was Chief Engineer until 1913; the late D. H. Campbell was Superintendent, and to him were primarily due the efficient organization and the splendid progress made. The writer was first Chief Engineer of the tunnel, later Assistant Superintendent and eventually Chief Engineer of the company.

Building Los Angeles Aqueduct Irrigation System

By Burt A. Heinly*

One of the largest development enterprises to be undertaken by a municipality has been actively entered upon in the past few weeks by the City of Los Angeles. This comprises the practical reclamation of over 137 sq.mi. (87,305 acres) by the construction of an irrigation system of 350 mi. of steel pipe lines and approximately 13 mi. of concrete supply conduits. One of the notable features of the task is that practically the whole works will be constructed without the use of the horse—mechanical equipment having taken his place. The building of the system follows as a consequence of the construction of the Los Angeles aqueduct, which will comprise the collection and storage works of the system. The engineering design of the irrigation system was described in detail in *Engineering News*, Feb. 18, 1915. This article will therefore be devoted to the plans for the consummation of the enterprise with a forecast of the plans in embryo that are now being developed for the additional use of surplus aqueduct water.

The land at present to be irrigated was annexed to Los Angeles in the early summer of 1915 for the sole purpose of giving the city the exclusive jurisdiction and management of the water-supply, the further provision being exacted of the territory that it should mortgage itself for the installation of the distribution system. The larger part of the valley (76,090 acres) did this in 1915 by voting a bond issue of $2,606,000. The remaining district (the Mission, 11,215 acres) accomplished the same purpose on Mar. 23, 1916, by voting a bond issue

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of $390,000. This makes the total amount available $2,996,000, or a cost per acre of $34.44. In addition, the municipality will expend an estimated $1,496,959 for conduits and reservoirs which will be used for irrigation demands, but which are primarily designed to provide regulation and storage of the aqueduct flow in its development of hydro-electric energy. The total planned expenditures on this system are therefore $4,449,959. To this must be added a further large but unestimated sum raised by frontage assessment where property owners to procure the water must carry it at private expense from the bonded laterals, which are spaced ½ mi. apart.

Money from the sale of bonds was not available until January of this year, so that instead of purchases of steel in a depressed market, as was hoped for, the city has thus far found itself in a position where it was required to purchase in an inflated market. The total estimated requirements for construction are 25,000 tons. Estimates based on Los Angeles water-works costs provided for building the works at a cost of 5c. per lb. for the steel in the ground plus 2½% for gates and fittings and 10% for engineering and all other incidental expense. This estimate was considered fair, but yet ample to cover contingencies. A review of the figures on contracts recently awarded will show the very narrow margin left for installation.

The first specifications called for the delivery of 4,097 tons of 8- to 54-in. pipe, delivered trench-side in 23-ft. lengths with rivets for field riveting where necessary. Bids were opened Dec. 28 and the contracts awarded to two local bidders; 2,456 tons at 3.29c. per lb. and 1,350 tons at 3.805c. per lb. Again on Feb. 23, bids were opened for 6,500 tons, but with the exception of a single item the prices asked ranged from 5½ to 6¾c. per lb. The one item was for 2,725 tons of sizes ranging from 8 to 18 in. at a price of 4.477c. per lb., with delivery completed in 210 days. Bids were rejected on all but the last item, which with the January contracts will keep the work going until about the first of next year. This will give opportunity to see whether by the improved methods of laying that have been planned the advanced price of materials can be counterbalanced.

All pipe of sizes up to and including 20 in. will be of field-driven joints. For the small sizes the trenching will be by trench excavators, three of which are now on the ground and two of which began operations Apr. 10. Trunk-line trench will be excavated by Marion Model 40 shovels, equipped with extra-long booms, of which the department has four ready for service. Backfilling will be with backfilling machines. Transportation of men and materials will be in 2½-ton 37-hp. motor trucks, with extra-long armored bodies built for the purpose in the department's shops.

On conduit construction, fortunately, war conditions offer no interference. One of the two concrete gravity supply lines has been under construction since the first of the year, and the 4,500 ft. of tunnel comprising one of the classifications will be excavated by May 1. The whole line, with a length of 6 mi. and a delivery capacity at the inlet of 7,500 miners' inches, will be ready for operation by June 1, or in time for the present irrigation season. The other line, the Chatsworth conduit, comprising 4,320 ft. of tunnel and 35,122 ft. of lined conduit, was started on Apr. 11, but cannot be completed and placed in operation this summer.

Happily, one of the main trunk lines for the valley is that which was constructed in 1913 and furnishes the City of Los Angeles with its domestic supply. The steel contracts now let provide for the installation of the laterals leading from this line, and many thousands of acres will be irrigated from this source this season. As these extend out at ½-mi. intervals and serve to ¼ mi. on each side, they provide water for each 10-acre tract. Where subdivisions have taken place into from 1- to 10-acre tracts, smaller laterals are run off at right angles so that the whole area will in time be gridironed. The city, for these laterals, makes a charge of 20c. per front foot—that is, 10c. per straight foot of pipe—and installs a 6-in. diameter No. 14 steel pipe. This charge at present cost of steel barely, if indeed, covers the cost. The system, being under heavy pressure—from 10 to 200 lb.—provides for domestic supply as well as for irrigation. On the former, meters are installed and maintained at the cost of the department; on the latter, weirs or portable meters will be employed.

As has been the rule in the past, the construction of the works, including the feeding of the men, is being undertaken by day labor under the direction of the engineers of the City Water Department.

When the system was first projected, its designer estimated that 20 years would be required for the full operation of the works; today it is confidently believed that the whole valley will be under irrigation shortly after the completion of the pipe lines, estimated at from 2 to 2½ years. Last season, 6,500 acres was under the water; this season, when it was foreseen that demands for steel in the East would make impossible satisfactory deliveries on the Pacific Coast, the irrigators formed associations and at their own expense built 7 mi. of flumes and 11 mi. of temporary ditches. There will therefore be under cultivation approximately 30,000 acres of land this season, much of which has heretofore been uncultivated or at best produced a single crop under dry-farming methods. In the construction of the aqueduct the municipality of Los Angeles has probably no counterpart among American or foreign cities for ambitious economic achievement. Entirely aside from the revenues accruing from the sales of water the present season demonstrates the almost incalculable indirect benefits already beginning to be realized from the creation of agricultural and horticultural wealth within the city's borders.

To further extend the use of aqueduct surplus water, there will shortly be placed before the voters the additional annexation of about 30,000 acres. This territory stretches away from Los Angeles to the sea on the southwest. Much of the area includes the Santa Monica Mountains, the western slopes of which it is proposed to water. The land is fertile, but at present for the most part waterless. With a supply from the aqueduct and cooled by the breezes of the Pacific, its slopes, valleys and tablelands comprise the most ideal estate and villa property in America. Following its annexation, Los Angeles will be in a position to form a territory of a single city and county government, the boundary lines being determined by the area that may be supplied from the aqueduct's flow. The plan is one of very far-seeing municipal construction in preparation for the economic handling of a large and dense population, primarily agricultural and horticultural, but essentially urban after a lapse of perhaps not many years.

Building Concrete Lighthouse on Brandywine Shoal

By T. J. Rout*

SYNOPSIS—Details of design and construction of a reinforced-concrete lighthouse to replace 60-year-old iron lighthouse in Delaware Bay. Concrete foundation caisson made on shore and towed to site. Concrete superstructure built from working platforms on and alongside old lighthouse.

Brandywine Shoal is about 2½ mi. long, running parallel with the main ship channel of Delaware Bay and is 11½ mi. north of Lewes, Del. At this point the bay is 16 mi. wide and the site has little protection against storms. The nearest harbor is at Lewes, and the nearest land is at Cape May, 7 mi. distant, the Delaware shore of the bay being 9 mi. away. The site has a submerged depth of 8 ft. at mean low water, and the tides have a mean rise and fall of 6 ft., with a current velocity of 3½ mi. per hr. The original structure on the site was an iron-frame lighthouse on screw-piles, erected in 1850 at a cost of $53,000 and the first of its type in the United States. The wrought-iron piles had deteriorated to such an extent that it became advisable to build a new structure near-by rather than to attempt repairs. Accordingly, in 1911 Congress appropriated $75,000 for a new lighthouse. Work was started in 1912 and completed in 1914. A one-year guarantee by the contractor expired in October, 1915.

Preliminary test borings made at the site showed very hard sand to a depth of 60 ft., and then a hard blue mud for 10 ft. more, the extent of the borings. For this condition a design was prepared consisting of a pneumatic caisson foundation 35 ft. in diameter and 37½ ft. high, built of 1¼-in. cast-iron plates, the whole supporting a cast-iron superstructure. At the first letting no bids for the complete structure were received. Bids were again invited under the same plans and specifications, but it was stated that due consideration would be given to proposals for a reinforced-concrete structure, the bidder to furnish detailed plans and specifications.

Two bids for a complete structure were received, one from the Phœnix Construction Co. in the sum of $175,000 for an iron structure, and the other from the Interstate Construction Co., of Mobile, Ala., for a reinforced-concrete structure, in the sum of $69,850 for the lighthouse and $2,500 for 900 tons of riprap to be placed around the foundation to prevent scour. This latter bid was accepted, and a contract was entered into to cover the work. It provided for partial payments and contained a clause that the contractor must guarantee the structure for a period of one year after its completion and acceptance by the Government.

As shown in the details in Fig. 2, the lighthouse is a cylindrical structure with a footing section of a cellular caisson cast on shore and floated into place, where it was bedded on timber piles and pinned to place with concrete piles. The superstructure, of decreasing circular sections, is of reinforced concrete built in place. It consists of a 3-story circular concrete dwelling, 26 ft. in diameter, supporting a circular watchroom and a standard third-order lantern. The circular walls of the superstructure are 6 in. thick, reinforced with ½-in. rods, 12 in. c. to c. in both directions.

The first floor consists of a 5-in. slab reinforced in both directions by ½-in. rods and supported on eight radial 14x22-in. beams. At this level a balcony extends entirely around the lighthouse. The balcony floor is supported on sixteen 12-in. brackets, while its roof is supported by sixteen 6x6-in. concrete columns. The upper floors consist of a 6½-in. slab reinforced in both directions by ½-in. rods. All were designed to carry a live-load of 200 lb. per sq.ft. together with the dead-load. There is a balcony with iron railing at the level of the third and lantern floor.

The balcony floor slabs were covered with a three-ply tar and felt roofing, and this waterproofing was covered with a 2½-in. layer of cement mortar. The inside floors were finished with a ½-in. coat of asbestos composition flooring. Room is provided for the lantern and foghorn machinery in the basement, and quarters for three men are in the upper stories.

Building and Placing the Foundation

The concrete foundation shell (35 ft. in diameter and 18½ ft. high) was erected on a launchway on the beach at Lewes, Del. It contained 104 cu.yd. of 1:2:2 con-

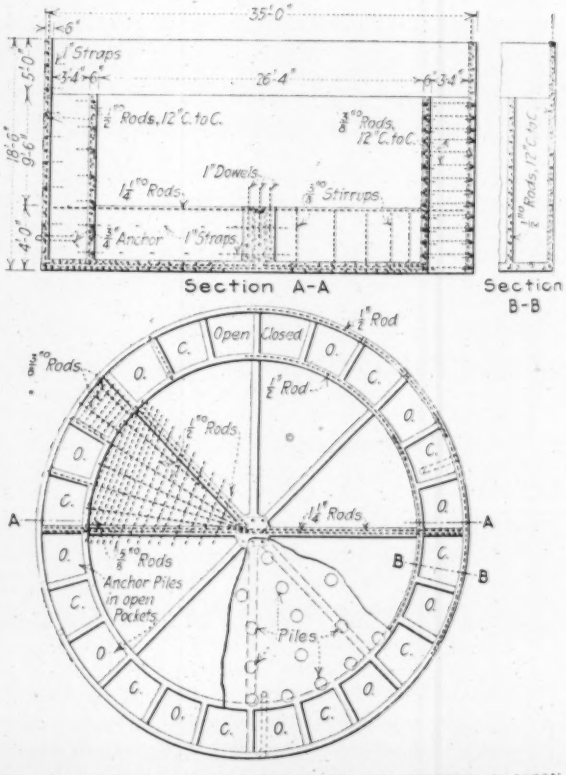


FIG. 1. DETAILS OF REINFORCED-CONCRETE CAISSON FOUNDATION FOR BRANDYWINE SHOAL LIGHTHOUSE

*United States Lighthouse Inspector, Philadelphia, Penn.

crete, 11,400 lb. of steel reinforcement and weighed about 225 tons. Details are shown in Fig. 1. The shell consisted of circular inner and outer walls, each 6-in. thick spaced 3 ft. 4 in. apart. An 8-in. concrete floor extended to the inner circular wall only. This floor was reinforced on the upper side by eight 10-in. by 3 ft. 4 in. radial beams. The outer and inner circular walls were joined together by twenty-four 6-in. radial partitions. Each alternate pocket thus formed was sealed at the bottom with an 8-in. floor, the other pockets remaining open. The reinforcement for the bottom consisted of two layers of plain iron rods ½ in. to ⅝ in. in diameter, spaced 6 in. to 12 in. on centers. The walls were reinforced by vertical and horizontal ½-in. rods, 12 in. on centers. The forms were of 7/8x8-in. horizontal boards, well nailed to 1x4 in. upright studs, spaced about 22 in. on centers.

While the concrete work was in progress on the shore, a working platform was erected by the contractor at the site to accommodate the storage of materials and to facilitate the work. It was supported on 35 piles driven 7 ft. into the sand. Its deck was 1,100 sq. ft. in area and was 9½ ft. above mean high water (Fig. 5). In addition to this, the contractor was allowed to use the platform around the old lighthouse. On this was erected the quarters for workmen, the hoisting engine, pumps, water tanks, concrete materials, etc.

After these preliminaries 74 pine bearing piles were driven at the site. Each pile was calculated to carry about 20 tons, had a penetration of 20 ft. and terminated 1 ft. above the top of shoal. The greatest number of piles put down in one day of 8 hr. was 20. All were driven by means of a jet, the water being supplied through a 2-in. hole reduced to a ¾-in. nozzle and furnished under high pressure by a duplex piston pump provided with its own boiler. The pump had a normal capacity of 600 gal. per min., but it was not necessary except on rare occasions to work it to the limit. A 2-in. pipe was screwed about 5 in. into the head of each pile to guide it and hold it in a vertical position. By means of an engineer's level and a file mark on the 2-in. pipe, the elevation of the top of the pile could be determined. In this manner the piles were jetted to the exact depth required, thus eliminating the services of divers. Near the center of the foundation, when the piles were close together, it was found that in jetting one pile down, another would rise. This trouble was overcome by lashing the 2-in. pipe follower to the falsework.

When the foundation had been prepared the shell was launched at Lewes in the same manner as a vessel. On account of a sand shoal, it struck on the bottom in 5 ft. of water at low tide, and it was necessary to dredge a cut in order to float it. Before the shell was launched, the open pockets were floored with 2-in. planking to exclude the water. In launching three of these were damaged and allowed the water to come in. This gave the shell quite a list. Much delay was experienced in securing a tug to tow the shell to the site, and some anxiety was felt lest a storm should damage it while anchored about 750 ft. from the shore and near the wharf. Water did not seep in to any extent.

A tug, by means of a 13-in. hawser towed the shell to its destination. It weighed about 225 tons, had a draft of 9 ft. 2 in. and a free board of 9 ft. 4 in. It was towed around the west end of the inner (or old) Delaware Breakwater, thence to the eastward around the south end of the outer breakwater, thence northward to the site. The total distance traveled was 14 mi., which was covered in 4 hr. For the first 3 mi. the towing was against the tide and

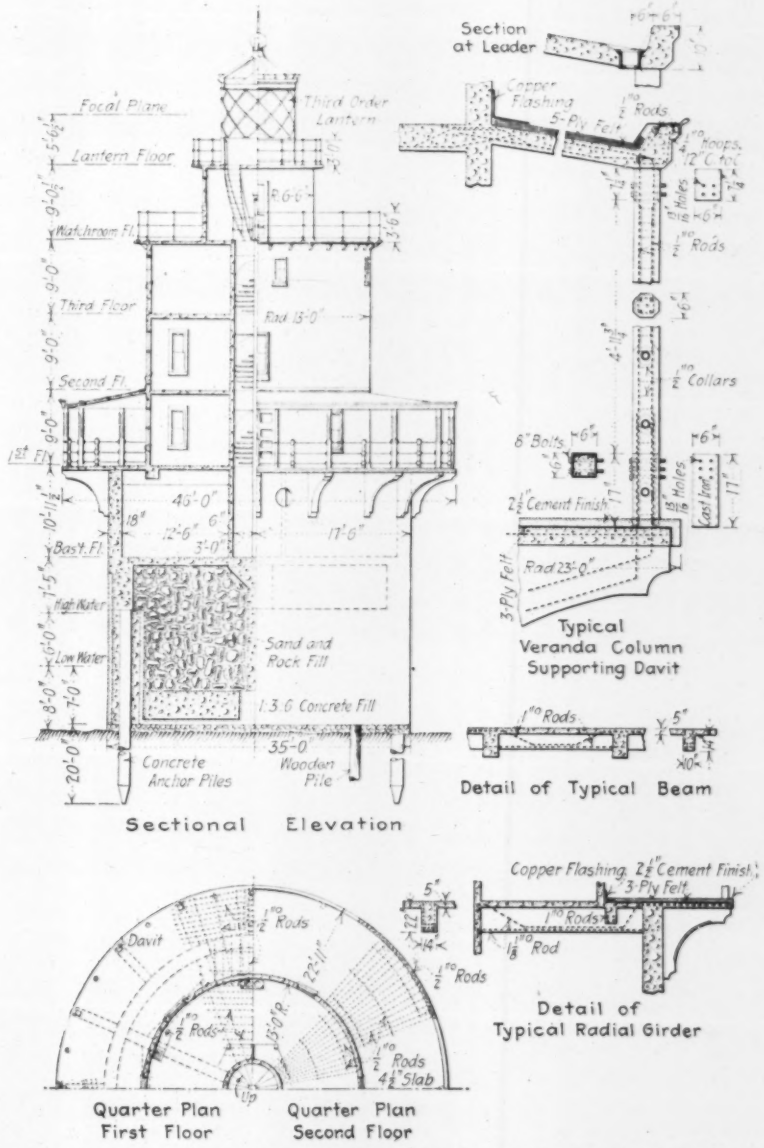
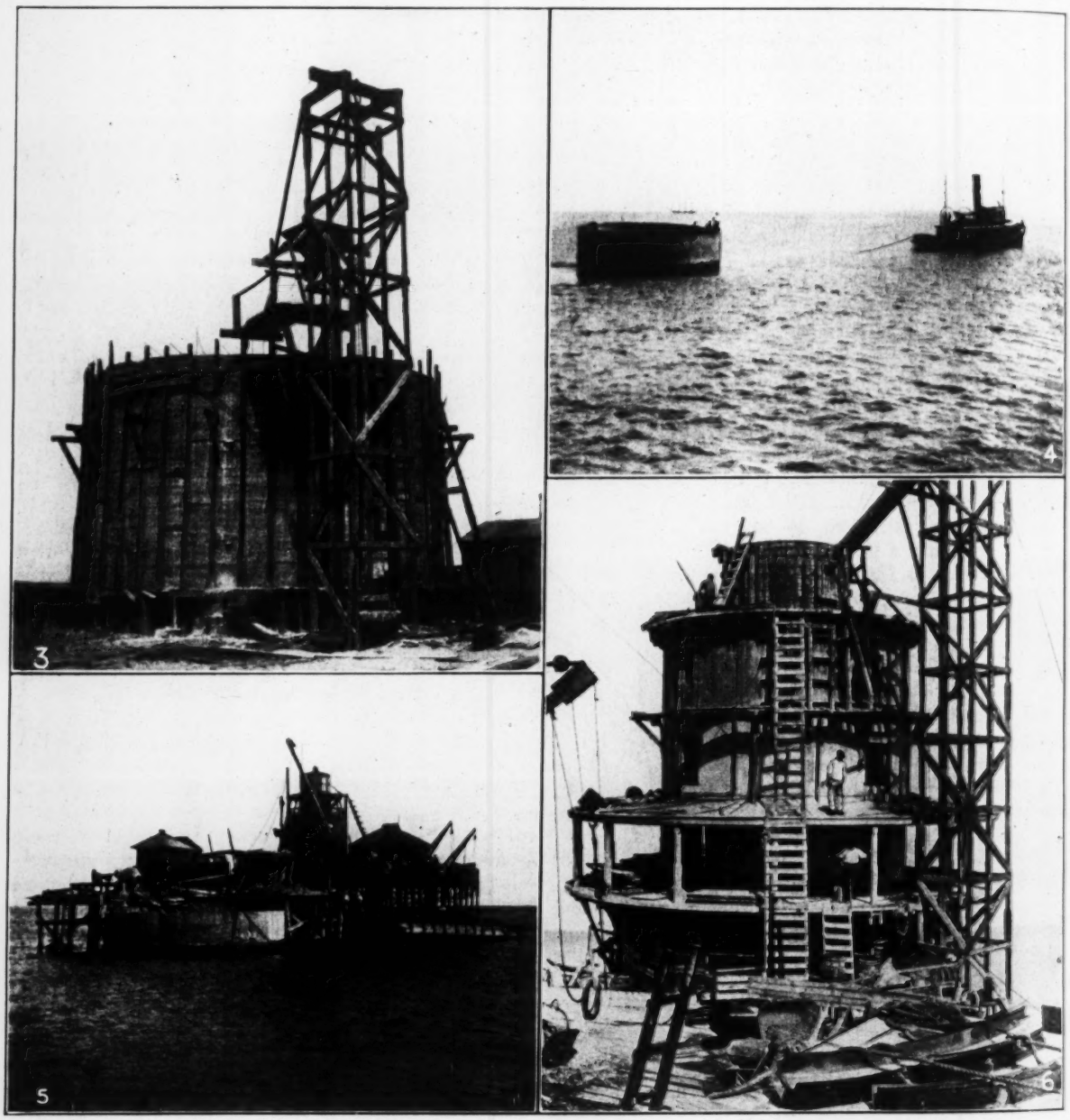


FIG. 2. CONSTRUCTION DETAILS OF BRANDYWINE SHOAL LIGHTHOUSE

slow progress was made, but after passing the outer breakwater, better speed was maintained on account of flood tide. There was a slight swell on, and at times the shell had a freeboard of only 7 ft. (Fig. 4). However, no water came inside it.

At high-water-slack the shell was floated into place and sunk upon its pile foundation by means of sea-cocks. To pin the structure down, twelve 16x16-in. concrete anchor piles, 34 ft. long, were driven in place through the open pockets. Each of these piles had a penetration of 20 ft. into the sand, weighed about 41½ tons and was calculated to carry 55 tons. They were put in place by means of two water jets. After the piles were in place, the bottoms of the pockets were sealed by depositing concrete in bags. The water was then pumped out, and the pockets were filled with concrete deposited in air. Concrete was also deposited in the closed pockets; after this the water was pumped out of the foundation and the space up to the tops of the radial beam was filled with concrete. Above this level and up to the basement floor excepting the water tank, the fill consisted of sand and stone.

The 12 anchor piles made of 1:1½:3 concrete were cast on shore. The reinforcement consisted of a ⅜-in. rod in each corner. The forms for two piles were erected parallel with each other and 16 in. apart. These piles were poured, the forms were then removed, the sides of the two piles well greased and a third pile was poured in the space between the other two. Three others were made in the same manner on top of the lower three. The lower end of each pile was pointed, and the upper end was



FIGS. 3 TO 6. VIEWS OF BRANDYWINE SHOAL LIGHTHOUSE DURING CONSTRUCTION

Fig. 3—Building the foundation caisson. Fig. 4—Towing the caisson to the site. Fig. 5—Work in progress, showing foundation caisson, working platform and old lighthouse. Fig. 6—The superstructure under construction

FIG. 7. THE NEW AND OLD BRANDYWINE SHOAL LIGHTHOUSES

provided with a heavy iron ring for handling purposes. After the foundation was made secure at the site in November, operations were suspended for the winter. The work was resumed the next May. The summer was devoted to the construction of the upper works. All material had to be brought in by barge and stored to the extent possible on the working platform and old lighthouse. Fresh water was used in mixing the concrete, and had also to be brought out from shore. The view in Fig. 6 shows the progress of this superstructure work, which was carried on in accordance with approved standards of reinforced-concrete framework.

Subsequent to the structural work, a 3-ft. layer of riprap was placed around the foundation as a protection against scouring.

The lighthouse is the first one of its kind in the United States located on a submarine site. Although the idea was novel, the success of the work justified the acceptance of the design, and it has demonstrated the suitability of this form of construction for open-sea lighthouse work. In this instance the structure not only was completed for a less sum than would have been required for a corresponding lighthouse of iron, but is lighter, was more rapidly built and will not cost as much to maintain. The storms since its erection have been abnormally heavy and submitted the structure to exceptional strains and stresses, which it withstood with success.

The work was done under the direction of the Lighthouse Service of the United States Department of Commerce.

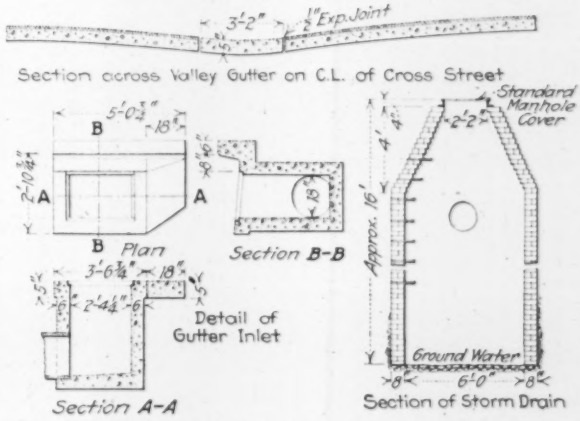
Storm-Water Drainage Sinks at Phoenix, Ariz.

A unique system of storm-water sewerage is being put into practice in Phœnix, Ariz. Instead of installing an elaborate system of storm sewers originally planned to cost half a million dollars the present city engineer, James B. Girand, has made use of some experience acquired in solving a mine-drainage problem in the Yuma desert and has adopted a system of drainage requiring no conduits. The storm water from gutters and catchbasins is led directly into bottomless manholes or sumps, where it runs out into the subsoil.

The details of one of these drains and of a curb inlet are shown in the accompanying sketch. Phœnix lies in the Salt River Valley, or more properly, in the old Salt River bed. On top of the upper strata of sand and silt are strata of gravel, through which the groundwater flows very readily. The water table varies in depth from 10 to 16 ft., and it is designed to carry these drains down to approximately this depth.

It has been found by experience practically impossible to flood one of these drains. The contents of a good-sized irrigating ditch have been turned into one for an hour without overflowing the drain. No difficulty has been encountered as yet in the silting up of the bottom, but this of course can be readily cured by scraping off the silt, as any catchbasin would be cleaned.

The scheme was originally adopted because the storm-sewer construction is made a part of pavement work, and it was soon found impossible to have any connected storm-sewer system where only short stretches could be put in from time to time. In this desert country, where the annual rainfall is only 9 or 10 in., the scheme of



STORM-WATER DRAINAGE BY MEANS OF SINK HOLES, PHŒNIX, ARIZ.

drainage adopted in Phœnix seems to offer an ideal solution; so far at least no objections have arisen. The sanitary-sewer system is of course separate.

The older streets have covered culverts to carry storm water past street intersections; but because of the infrequency of rains this provision has been decided unnecessary, and shallow valley gutters of the type illustrated are being used to a considerable extent.

Compression Test for Keel Block—An important test was conducted recently by the United States Bureau of Standards to determine the ultimate strength of a cast-iron keel block. As designed, the block was expected to withstand a load greater than could be exerted by any testing machine in existence. It did withstand the full capacity of the bureau's testing machine (10,000,000 lb.) when the load was applied over the entire bearing surface of the block, but when the load was applied over part of its bearing surface it failed at 9,600,000 lb. The test of the block itself was preceded by several preliminary tests to determine the strength of oak timbers, which are usually placed between keel blocks and the keel of the ship. At loads from 300,000 to 800,000 lb. the timbers were completely shattered, the variation in the load depending entirely upon the variation in the area over which the load was applied. After these preliminary tests the keel block was subjected to a load equal to the capacity of the machine. At about 6,500,000 lb. several sharp reports were heard, but after the full load was applied there was no apparent damage to the exterior of the block. On dismantling it, however, it was noticed that several of the webs of the various sections were cracked. It was then reassembled, and the load applied over a smaller area, when it failed at 9,600,000 lb. with a very loud report and almost complete shattering of the various sections, throwing parts of them a distance of 12 ft.

Activated-Sludge Process on Stockyards Sewage*

By Arthur Lederer†

The Sanitary District of Chicago began experiments with the activated-sludge process of sewage purification on Stockyards and Packingtown sewage in April, 1915. The operation on the fill-and-draw plan was carried on in two galvanized-iron tanks, each holding approximately 200 gal. of sewage. These experiments were continued well into the cold season, being discontinued when the contents of the tanks froze solid. Certain observations were made, which can be explained by the effect of low temperatures upon the process. These observations were substantiated on the larger four-unit installation of the Sanitary District, designed to treat from 30,000 to 100,000 gal. on the continuous-flow basis daily. This installation was put into operation early in 1916, and is under the direction of Langdon Pearse, Division Engineer, and George M. Wisner, Chief Engineer.

The object of this short paper is to elaborate certain facts of a chemical and biologic nature which have presented themselves in the course of operation, and not to furnish any prescription for the treatment of the Stockyards waste. The operation features now being worked out will require much time and experience before a final recommendation can be made. Economically, the continuous-flow process is apparently preferable, but it has certain disadvantages which the fill-and-draw plan avoids. Experience from our experiments and from those of others will probably indicate the solution. As in other sewage-treatment processes, so is this one governed primarily by the composition of the waste handled. The process being largely of a biologic nature is greatly influenced by the temperature of the sewage. In this respect the Stockyards waste lends itself readily to the process, the temperature throughout the entire year varying between 60 and 90° F., at the Center Ave. outlet. The loss in temperature in the plant is only a few degrees in the coldest winter weather. By far the greater percentage of the sewage treated is packinghouse waste. The variation in the day and night flow is extremely marked qualitatively and quantitatively as well. The free-oxygen demand is approximately 8 to 10 times greater than that of the domestic sewage in Chicago.

The changes of the nitrogenous constituents during the aëration process have been carefully studied. Our experience has coincided, so far as I am aware, with the experience of other observers. During the warmer season a reduction of the free ammonia to about 1 or 2 p.p.m., and an increase of the nitrites to 5 or 10 p.p.m., indicate complete oxidation and clarification. This ceased to be the case, however, when colder weather set in with the small galvanized-iron tanks, which were easily affected by changes in temperature in the air. Absolute stabilities were reached in cold days with the free ammonia actually increasing several hundred per cent., and with little, if any, change in the nitrites and nitrates. The reduction of the organic nitrogen was just as marked as in summer. Clarification was very satisfactory. The results I speak of are those noted when the effluent showed a relative stability of 100 or thereabouts. With the small galvanized-iron tanks, in which the wastewage quickly chilled, it took a considerably longer time in the cold weather to obtain such a high stability, but the chemical results were consistently as noted.

It is clear that in such cases the mechanical features of the process outweighed the biologic features. The highly putrescible colloids have simply been whipped out of suspension by the continuous agitation. Repeated observations indicate that the mere mechanical removal of the colloidal matter from sewage brings about an improvement far out of proportion to the actual percentage of substance removed. There is no doubt, however, that there is some biologic activity even in a liquid near freezing; otherwise, we could hardly account for the persistent increase in free ammonia. We further noted various active protozoa, such as infusoria and trachelomonas, in the sludge at all times. More highly developed animal or plant organisms were not found.

Our work indicates that the temperature of the liquid treated will be a controlling factor. On a large scale temperature changes will probably be much lower than on the very small scale of 200-gal. steel tanks exposed to weather.

During the cold weather we had no ready chemical index to go by, although the regular routine tests of long duration were available. The removal of the colloidal matter was the only immediate indication of accomplished oxidation. This forced us to determine regularly the turbidity of the settled aërated sewage. Used with the methylene-blue putrescibility test, a fairly definite working relation can be established. The tabulation of a large number of results obtained shows that the stability is 100 with turbidities of 10 p.p.m. or less. With a turbidity of 15 p.p.m., the relative stability varies usually between 50 and 100. With turbidities above 15, the quality of the effluent shows rapid deterioration. At turbidities ranging from 20 to 25 the stabilities are usually below 50. To compare turbidities above 25 p.p.m. with stabilities appears unsafe. Such stabilities are without exception very low. The relation spoken of is bound to vary with sewages of different character.

Recently, with the advent of warmer weather, the nitrites are again picking up in the effluent, and no doubt our ammonia index will again serve the purpose. The determination of other constituents, such as the organic nitrogen, albuminoid ammonia, permanganate oxygen consumed, chlorine and the bacterial content are merely of scientific interest. They are not essential for a routine control. This holds good to a certain extent for the dissolved oxygen, but it is quite conceivable that the rate of de-oxygenation at a given temperature can be made to serve as an index of the degree of stabilization accomplished.

The quantity of the settling suspended matter in the final effluent merely indicates the efficiency of the settling process, and has nothing to do with the activated-sludge process proper. Packingtown sewage completely oxidized by the activated-sludge process is clear with a slightly yellow tint, barely noticeable in small bulk.

*A paper read at the meeting of the American Chemical Society, at Urbana, Ill., April, 1916.

†Chemist, Sanitary District of Chicago.

Electrification of the Salt Lake & Los Angeles Ry., in Utah, is to be carried out in connection with an extension of the line. The railway is 15 mi. long, extending from Salt Lake City to Saltair, a resort on Great Salt Lake. H. A. Strauss, consulting engineer, Chicago, has been engaged as engineer for the work.

Pressure of Wet Concrete on the Sides of Column Forms

By A. B. McDaniel* and N. B. Garver†

SYNOPSIS—Tests made on columns built up in laboratory and on posts of a bridge under construction show pressure of wet concrete on sides of forms. Describes methods to measure pressure.

Several investigations have been carried on in the past to determine the lateral pressure exerted by wet concrete on forms, but very little accurate information has been derived.

In 1894 Ernest McCullough made a series of tests in which the pressures were measured by placing a 7/8-in. board in the side of a form and pouring in concrete until the board broke. The pressure obtained was equivalent to that of a liquid weighing about 80 lb. per cu.ft. The weight of the equivalent liquid was probably only about one-half that of the concrete. Owing to the crude manner in which these experiments were conducted, little importance can be attached to the results.

In 1908 a very extensive series of tests, lasting throughout the season, was carried on by Maj. F. R. Shunk, U. S. A., during the construction of the Mississippi River lock No. 1 near Minneapolis, Minn. The tests were made during the pouring of monolithic blocks of concrete 25.75 ft. high. The concrete was very wet and weighed about 152 lb. per cu.ft. The lateral pressure was measured by means of a piston connected to a scale beam. The results indicated that a hydrostatic pressure corresponding to that of a liquid weighing 152 lb. per cu.ft. was obtained at first; but as the head increased, the concrete began to act more as a solid, so that later the pressure remained practically constant. It was also found that the head at which the concrete began to act as a solid varied with the rate of pouring, the temperature, the pressure and the condition of agitation of the surface.

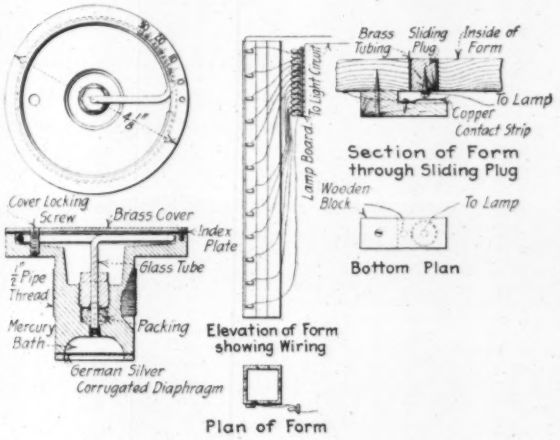


FIG. 1. DETAILS OF GAGE AND METHOD OF INDICATING HEAD OF CONCRETE

In 1913 E. B. Germain, Assistant Engineer for the Aberthaw Construction Co., carried on a series of tests during the construction of a mill building in Cambridge, Mass. A wet 1:1½:3 mixture was poured at a rapid rate into two columns 20 in. square and 20 ft. high. The gages were hot-water bottles filled with mercury, so that the lateral pressure was measured by reading the level of the mercury in the tubes. A hydrostatic pressure equivalent to that of a liquid weighing from 140 to 150 lb. per cu.ft. was obtained.

University of Illinois Laboratory Tests

Two series of investigations were made during the college years 1913-14 and 1914-15 by undergraduate students of the civil-engineering department, University of Illinois, under the supervision of Professor McDaniel.

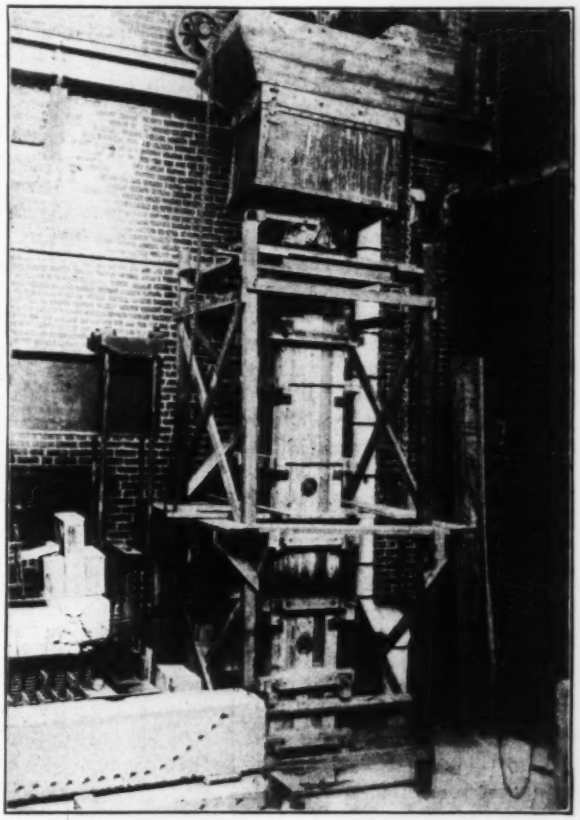


FIG. 2. VIEW OF LABORATORY COLUMN FORM

The tests were made upon two sizes of column forms, and the pressures were measured at five points along the sides of the forms by diaphragm pressure gages.

The tests were made on 12-in. and 20-in. square column forms, the height being 12 ft. in both cases. The forms were made of planks with ship-lap joints and were built of 4-in. interchangeable sections. No trouble was experienced with leakage from the forms (Fig. 2).

The pressure gages were made especially for these tests and were of a type that was successfully used to measure the earth pressures during the construction of the Pennsylvania R.R. tunnels in New York City. Each gage

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†Associate in Civil Engineering, University of Illinois.

(Fig. 1) consisted of a flexible German-silver diaphragm acting upon a reservoir containing mercury. The pressure was indicated by the position of the mercury in the tube. The graduation of the tube was arbitrary, so that it was necessary to calibrate it. A thick layer of grease covered the diaphragm during the tests, to protect it from temperature changes and small falling particles.

A unique method was employed for determining the height of the concrete in the forms (Fig. 1). Brass tubes were set into the forms at 1-ft. intervals. Wooden plugs fitted with wires and brass screws were set into these tubes. Copper strips wired to electric lamps were fastened over the holes so that the lamps were lighted when the plugs were forced out and made contact. The plugs were kept well oiled so that they would slide easily in the tubes.

A sheet-iron funnel, supported on the top of the tower, directed the concrete from the bottom-dump bucket to the center of the form, which was braced to the tower. The bucket was constructed of sheet steel with a wooden extension and had a total capacity of 48 cu.ft.

The ingredients for the concrete were proportioned by volume. A 1:2:4 mixture of standard cement, glacial sand and crushed limestone was used in all the tests. The concrete was mixed in a ½-yd. batch mixer. For the 12-in. column tests the concrete was mixed in two batches, the first being dumped on the floor and later incorporated with the second batch. For the 20-in. column tests three batches were necessary. The material was dumped from the mixer onto the concrete mixing floor and was then shoveled into the skip. The skip was raised by a traveling crane and moved into position over the column form.

After the concrete was mixed preparatory to the pressure tests, sample cylinders were molded and later tested to determine the crushing strength of the concrete. The average strength of twelve 8x16-in. cylinders was 1,040 lb. per sq.in. at an age of 28 days.

A Bourdon gage was calibrated with a Crosby gage tester and then connected to the end of the gage calibrator to which the pressure gages were attached. The gages were calibrated before each pressure test. The temperatures of the air and the water were taken during each calibration. As soon as the gages were calibrated, they were placed in the form and the test began. Calibration curves were plotted for the readings of the Bourdon and of the pressure gages. These curves were then used to reduce the observed readings of the pressure gages for each test.

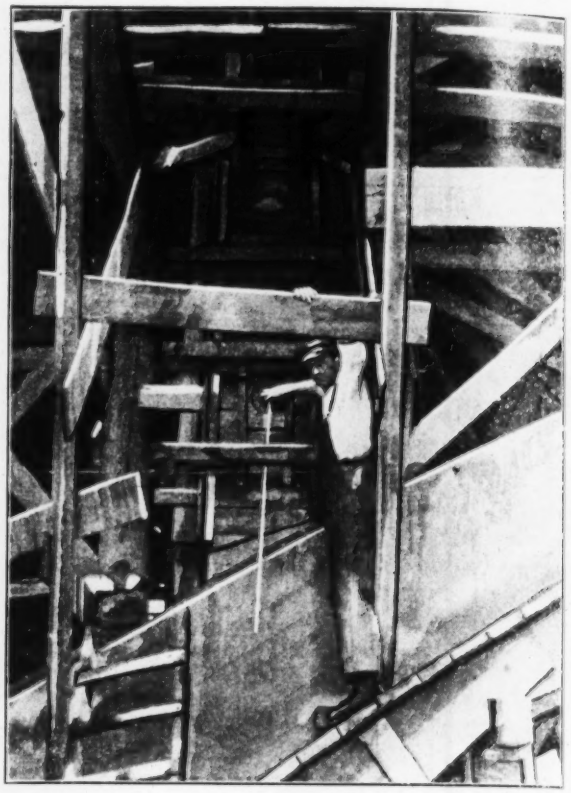

FIG. 4. VIEW OF BRIDGE POST FORM UNDER TEST

The gate of the bucket was opened wide enough to secure a continuous flow of concrete through the hopper into the form. A gong was struck every 15 sec., and the highest pressure reading during the interval was recorded by the observer at each gage. Several tests were made on each size of column, and the consistency of the concrete and the time of pouring were varied to determine the effects of these factors upon the lateral pressure.

The accompanying diagrams (Fig. 3) give the results of four tests with the 12-in. square column and of the two tests for the 20-in. square column. The readings of the different gages are noted by symbols that are designated on each diagram.

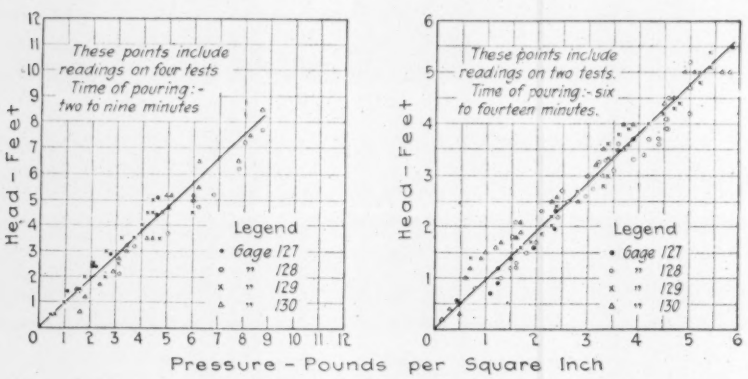
These points include readings on four tests. Time of pouring:- two to nine minutes.
Head - Feet
Legend
• Gage 127
○ " 128
× " 129
△ " 130
These points include readings on two tests. Time of pouring:- six to fourteen minutes.
Head - Feet
Legend
• Gage 127
○ " 128
× " 129
△ " 130
Pressure - Pounds per Square Inch

FIG. 3. PRESSURE-HEAD DIAGRAMS ON 12-IN. AND 20-IN. LABORATORY COLUMNS

The tests of the 12-in. column form varied in time of pouring from 3 to 9 min.; and of the 20-in. column form, 6 to 14 min. The consistency of the concrete varied from quaking or medium to very wet. Difficulty was experienced in securing a uniform rate of pouring during any one test. It was noticed that the material as it discharged from the skip was not of a uniform consistency, owing to the loss of water in handling the concrete and the tendency of the wetter upper section of the concrete in the skip to discharge before the general mass.

An effort was made to determine the effect of impact by special tests in which the concrete was poured in layers 1 ft. in depth and an intermission of 15 sec. allowed between successive layers. The highest reading on each gage during the pouring of each layer of concrete and also the lowest reading during the succeeding interval-

were recorded. The results gave in each case a definite reduction in pressure after the pouring ceased; but as only one test was made on each size of column, there is insufficient information for drawing conclusions.

Conclusions of Laboratory Tests

The tests were not sufficiently comprehensive to permit the statement of any definite laws regarding the lateral pressure of wet concrete. Conditions of testing were found to be so variable that it is difficult to make close comparisons between the results of different tests even on the same size of column form. However, it is believed that the following general conclusions are justifiable:

1. The lateral pressure increases with the head up to a certain point, after which the pressure remains nearly constant until the pouring ceases. It is probable that, during the early part of the pouring, the concrete is supported by pressure upon the base of the form, and later a considerable part of the concrete is supported by arch-like action on the sides of the form. In this respect the action of green concrete seems to be similar to that of grain, seeds, clean dry sand, etc., in a bin.

2. The lateral pressure in general corresponds to hydrostatic pressure for wet concrete.

3. The lateral pressure increases with the rate of pouring and the degree of wetness of the consistency.

4. The lateral pressure is about the same for column forms up to 20-in. square.

Tests Made on Large Bridge Post

A series of field tests were conducted on a reinforced-concrete arch viaduct that was under construction across the North Fork of the Vermilion River at Danville, Ill., during the summer of 1915. The object in making these tests was to get more data than had been obtained in the laboratory and also to get information by which a comparison might be made of lateral pressures under laboratory and field conditions. It is often argued that results obtained in the laboratory are of little value, because conditions do not approximate those existing in actual construction.

The viaduct is of the arch-rib type, with spandrel posts, floor-beams and slab floor. The tests were made on the spandrel posts of the longer spans. These posts have a cross-section of 23x30 in. and a maximum height of about 15 ft. They have both vertical and horizontal reinforcing bars.

The vertical reinforcement consists of 1-in. square bars, one of which is placed in each corner of the post. The horizontal bars are ½-in. squares spaced about 3 ft. on centers. Particular care was taken to so locate the pressure gages that the reinforcing bars would not interfere with the pressure of the concrete upon the gages.

The apparatus (Fig. 4) consisted of the same iron rings and pressure gages that served in the laboratory tests, a level rod with a flat piece of sheet-iron fastened to the end to provide bearing area (for measuring the height of concrete), a stop watch and a whistle. Two rings were placed in each of the four long posts on one span and just as near the bottom of the post as was practicable. Since the spandrel posts, floor-beams and floor slabs for one span were poured in one day, there was no opportunity to move the rings during the process of pouring and get readings on other posts in that span. By the method outlined it was possible to get eight gage readings during the pouring of one span.

The materials used in making the concrete consisted of a standard cement and a good grade of washed Wabash River sand and gravel. The proportions by volume of cement, sand and gravel were 1:2:4. The maximum size of gravel permissible was that which would pass a 1¼-in. screen. A batch mixer mixed the concrete, and a spouting system transported the mixed concrete to its place in the forms. The consistency of the mixture was wet. The rate of mixing was about one batch per minute. It required from 7 to 9 min. to fill one of the spandrel posts with concrete.

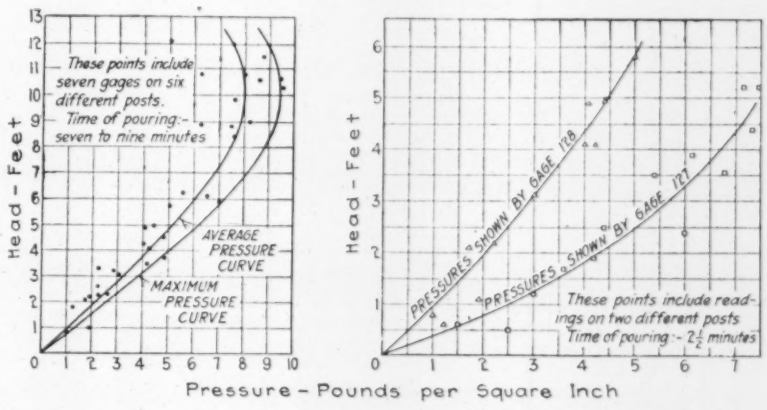
Head - Feet
These points include seven gages on six different posts. Time of pouring:- seven to nine minutes
AVERAGE PRESSURE CURVE
MAXIMUM PRESSURE CURVE
PRESSURES SHOWN BY GAGE 128
PRESSURES SHOWN BY GAGE 127
These points include readings on two different posts. Time of pouring:- 2½ minutes
Pressure - Pounds per Square Inch

FIG. 5. PRESSURE-HEAD DIAGRAMS FOR 23x30-IN. POSTS ON BRIDGE

The gages were calibrated both before and after making each series of tests in the manner described previously. Four men were required for carrying on the tests—one to put in place each of the two gages in a post form and to record the pressure readings when the concrete was poured; one to time the pouring of the concrete with a stop watch and blow a whistle as a signal for the gage readings to be taken and the height of concrete to be measured; and one to measure the height of concrete when the signal was given.

The increase of pressure as indicated by the gages was not constant, as one might suppose. The gages indicated an increase of pressure by jumps, as though the aggregate would form an arch across the column form and by suddenly giving way cause the gages to show a sudden rise in pressure. It was also noticed that upon the discontinuance of pouring of concrete for a few seconds the pressure would begin to drop. There was some leakage of water from the forms, but apparently this had no effect on the pressure.

If, after the concrete had reached a height of 5 or 6 ft. above the gages, the pouring was discontinued for a few seconds, the gages would seldom show an increase in pressure when pouring was resumed. Apparently the concrete had had sufficient time to settle into a stable position, and the impact of the new concrete was not sufficient to jar it loose and thus increase the pressure at the gages.

A total of 16 readings was taken in the field tests. Of these 16, nine appeared to be very consistent, and they

were used in plotting the curves shown in the accompanying diagrams (Fig. 5). The other seven gage readings were of such an erratic nature that it was not thought advisable to use them. In some cases no pressure whatever was recorded, indicating that there had been some obstruction in front of the diaphragm, while in other cases no pressure was indicated at first, but after a while there would result a sudden rise in pressure amounting nearly to the same maximum recorded by the other adjacent gage.

While pouring the concrete, the end of the spout rested on the floor-slab forms and the concrete was permitted to drop from this point into the post forms. In falling, the concrete would strike one side of the post before dropping to the bottom. Apparently this had no effect on the gage readings for the long posts; but for the short posts, for which the pressures are shown at the right in Fig. 5, gage 127 was on the side opposite the spout, and the curve indicates that the concrete dropping near the gage caused an appreciable increase in the pressure. Gage 128 was placed on a side of the form adjacent to the side on which gage 127 was located.

The diagrams give the recorded pressure in pounds per square inch for heads up to about 12 ft.

Conclusions From Field Tests

It will be observed that the pressure gradually increases with the head until a maximum is reached, after which the pressure falls off. The height at which this maximum pressure occurs depends upon the consistency of the concrete and upon the rate of pouring.

The actual pressures recorded approximate very closely that of a liquid having the same weight as the concrete, or about 145 lb. per sq.ft. per ft. of head.

The results obtained from the field tests agree closely with those secured from the laboratory tests.

Concrete falling against the forms may result in high lateral pressures due to impact.

A value of 145 lb. per sq.ft. per ft. of height would be a rational value for lateral pressure to use in the design of forms.

The results of these tests are not conclusive, but it is believed that they are sufficiently consistent and accurate to furnish lateral-pressure values which may be used as a basis for the design of forms under average working conditions.

Details of Old Iron Viaduct in Service 37 Years

By Edgar K. Ruth*

In *Engineering News* of Apr. 6, 1916, the writer described briefly the plant used for the construction of the new reinforced-concrete arch viaduct that will carry Park Ave. over Kemper Lane into Eden Park in Cincinnati. In the design and operation of this plant the contractor made profitable use of one span of the old iron viaduct replaced by the new viaduct. It has been suggested that a brief history and description of this old structure would be interesting.

The original Park Ave. Viaduct, or "Kemper Lane Bridge," as it was often called, was built probably in the early sixties. Painstaking examination of the city records and annual reports of the city engineer as far back as 1854 reveals only that this old structure was about 267 ft. long, that it consisted of several short iron truss through spans, that its first cost was about $25,000, and that in 1876, being in a "ruinous condition," it was closed to traffic and torn down.

The new viaduct, completed in 1878, did not, however, contain a great deal of new iron, for with a commendable effort toward economy, instead of discarding as useless the material in the old viaduct, the bridge

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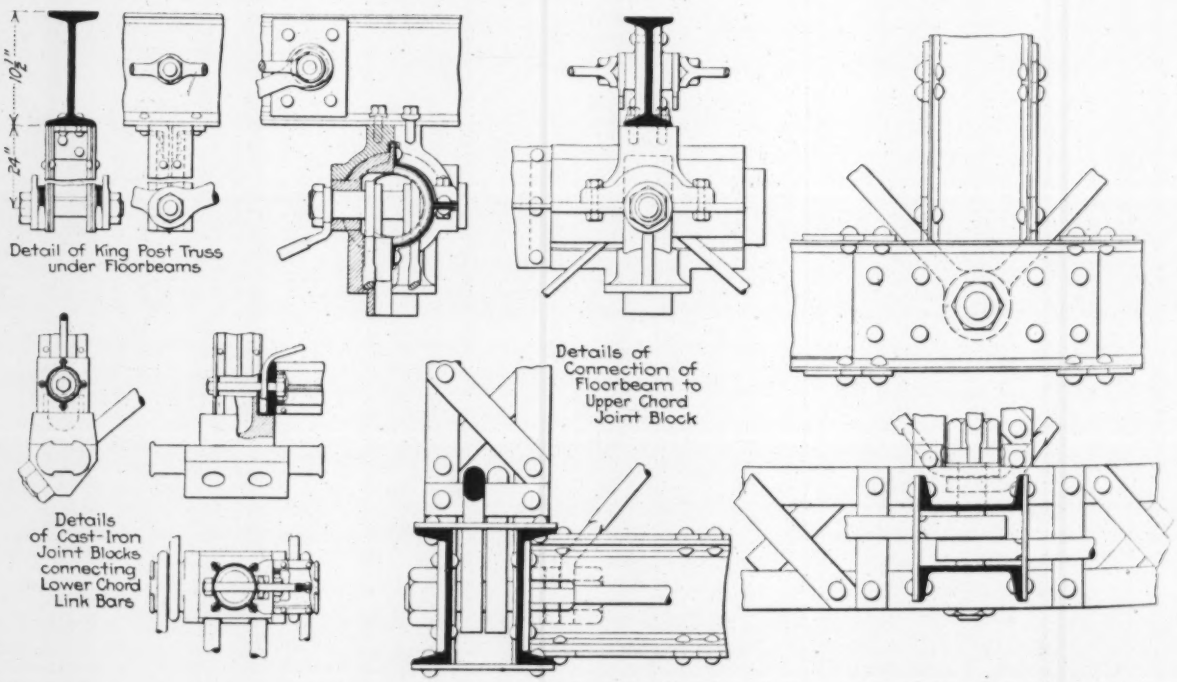

10½"
24"
Detail of King Post Truss under Floorbeams
Details of Connection of Floorbeam to Upper Chord Joint Block
Details of Cast-Iron Joint Blocks connecting Lower Chord Link Bars

FIG. 1. SOME DETAILS OF THE STRUCTURAL IRON WORK ON THE PARK AVE. VIADUCT AT CINCINNATI

FIG. 2. VIEW OF ONE END OF THE OLD PARK AVE. VIADUCT, CINCINNATI

engineer utilized a large part of it in building the new structure. The cost of the ironwork was about $10,000, and the entire improvement, including masonry and excavation, cost $22,500. The total length of the new viaduct was 353 ft., made up of six Pratt truss deck spans, one of 66 ft. over Kemper Lane, four of 57 ft., and one of 53 ft. at the Eden Park end.

Quoting from the annual report of the city engineer for 1878: "The new superstructure is far superior to the old one as regards strength, durability and appearance, but of course the details of construction are not as perfect as they would have been could less of the old materials have been used. As it is, nearly all of the iron of the old bridge was worked into the new one, while the woodwork is entirely new."

Some of the details of this "new" viaduct are of interest, in view of the fact that it was used continuously from 1878 to 1915, required practically no repairs, except to its wooden floor, and was painted only a few times in that period.

Each span consisted of two Pratt trusses 17½ ft. c. to c., with 8-ft. panels, supporting 10½-in. I-beam cross-girders 32 ft. long. These I-beams cantilevered beyond the trusses 7 ft. to carry the sidewalk on each side of the 18-ft. roadway. They were trussed by shallow king-post trusses with eye-bar tension members and 4-in. I-beam struts.

The design of the trusses was unique, in that the upper-chord members, vertical web members and horizontal struts between corresponding panel points in the lower chords of trusses were all built up from Phœnix-column sections, and the lower-chord tension members were wrought-iron link bars. Special cast-iron joint blocks were used at panel points to connect the various members.

The viaduct was torn down in July, 1915, to make way for the new concrete structure, and about 105 tons of material was sold as scrap. The bars and links showed little signs of corrosion, but the Phœnix sections were in many instances badly pitted and rusted, especially at the ends, where connected to the joint blocks.

Steel Shell for Water Tunnel

Part of the 8-ft. suction tunnel leading from the 12-ft. Wilson Ave. intake tunnel of the new Mayfair pumping station, at Chicago, has an exterior steel shell. The tunnels from the east gate shaft to the two screen shafts were excavated in clay in the usual manner. The clay being hard, an advance of about 6 ft. was mined and concreted per shift. The suction tunnel in the building is subjected to great pressure from the adjoining foundation walls of the pumproom and heavy pump foundations. For this reason and because better progress and a certain saving can be made if the mining and lining operations can each be carried on continuously (instead of alternating, as is customary), steel lining plates were employed in this part of the tunnel. These plates form a continuous steel shell of the outside diameter of the tunnel and the concrete lining can be deferred until the entire tunnel is excavated. The location of the tunnel made very heavy reinforcing necessary, and this too could be handled much more advantageously in a completed bore than in the usual crowded conditions resulting from alternate mining and lining. This steel shell was described in a paper on the Wilson Ave. tunnel, read before the Western Society of Engineers by Henry W. Clausen, Engineer of Water-Works Construction, Chicago.

Coöperation Between the Boston Health and Police Departments is to be increased. Heretofore the police have helped in the detection and prosecution of offenses against health laws and regulations. Hereafter the police will give notice of conditions which do not admit of prosecution by them, but which are subject to remedy by direct action of the health authorities.

Engineering Literature

CORRESPONDENCE

Engineering Thermodynamics

Sir—The reviewer of Moyer and Calderwood's "Engineering Thermodynamics," in *Engineering News* of Feb. 17, 1916, has apparently the idea that, if the subject is to be presented clearly, it is necessary to use only "words of one syllable." There is, however, a big jump from the abstruse treatises on this subject by Zeuner, Rankine and Peabody to discussions limited to words of one syllable. It is the jump from involved and partly explained calculus to the language of the primary grades. There is no reason to assume that the authors made such claims as regards the length of words. They had in mind, however, the preparation of a book in which the text would be "largely self-explanatory."

It is admitted by the reviewer that many difficulties with other treatises have been overcome in this one. His explanation is that the difficulties have been avoided "by the omission of some of the more difficult subjects normally considered desirable."

The argument that thermodynamics should be a "hard subject" and not a college "snap" has no more reasonableness than that of the old-fashioned pedagogue who contends that algebra is necessary for the proper mental development of girls in city high schools, in spite of the fact that these girls are notably deficient in the fundamentals of arithmetic. Doubtless, thermodynamics as given in the college of engineering with which the reviewer is connected is arranged to give the maximum amount of pleasure to the instructor in presentation and the maximum amount of difficulty to the student. I am confident that, after 10 years of experience in engineering, practically all of these students will join those who condemn such methods of teaching. In connection with their practical work they will probably never refer to their textbook, but will use books that are written in plain English, with little calculus; the kind of thermodynamics found, for example, in Kent's "Mechanical Engineers' Pocket Book."

The authors believe it is a crime to teach the subjects of thermodynamics and descriptive geometry according to the old-fashioned methods. Teachers having the viewpoint that these subjects should be made difficult for the sole purpose of separating the "sheep from the goats" cannot justify themselves pedagogically.

The reviewer says there are statements "likely to be misleading for the student." His first citation is the use of the words "practically perfect vacuum," but no page reference is given. These words are used on page 10 in regard to gas in a cylinder connected to an air pump. It seems unnecessary to demonstrate that a "perfect vacuum" was impossible with any apparatus.

Exception is also taken to the statement of the reviewer that it is necessary to "distinguish between adiabatic changes which are isentropic and those which are not." This is a matter which cannot be settled on the basis of authority. The authors have certain ideas as to the importance of this matter, and the reviewer has different notions. It is the opinion of many engineers that the "average student" will have no use for this distinction.

Other trivial statements in the review are of similarly doubtful accuracy and may be judged as to their merits by the preceding discussion.

J. A. Moyer, J. P. Calderwood.

Massachusetts Department of University Extension.
State House, Boston, Mar. 25, 1916.

REVIEWS AND NOTES

Harbor Section Added to Civil Engineers' Pocketbook

AMERICAN CIVIL ENGINEERS' POCKET BOOK—Mansfield Merriman, Editor-in-Chief. Third Edition, enlarged. New York: John Wiley & Sons, Inc. Leather; 4x7 in.; pp. 1,551; illustrated. $5 net.

Although the third edition of this standard pocketbook contains a number of minor changes, its important feature is the addition of an entirely new section on "Harbor and River Works," by Rear Admiral Frederic R. Harris, of the Corps of Civil Engineers, United States Navy, now chief of the Bureau of Yards and Docks. Thus is supplied the one field of civil-engineering practice conspicuously absent in the earlier editions.

Of the 95 pages in the new section, only 12 are devoted to rivers, the other 83 taking up the details of harbor engineering, or at least those types of marine construction which result from the necessity for harbors. In this respect the author has a certain justification not only because river works appear in some detail in other sections of the pocketbook, but because while the literature of river control is fairly extensive, American books on harbor engineering are practically nonexistent.

The section starts with a brief treatment of the hydrology of harbors, followed by details of protective structures such as breakwaters and groins. The river chapter, which follows, has the usual hydrological facts with a short, rather incomplete exposition of regulation and control. The next three chapters are on quays, piers and docks and are the best of the section. A final chapter is mostly devoted to port machinery.

The new section is quite up to the high standard of the rest of the book. In view of the current agitation it is somewhat strange that more attention was not paid to river control, but after all, the knowledge in this field does not lend itself readily to pocketbook condensation. So, too, it seems that more space might have been paid to quay and dock walls and less to dry docks. Dry-dock construction is necessarily limited, but quay walls are being built everywhere there is a navigable stretch of water. In no other branch of structural engineering has there been such a pronounced development, and the detailing of this development would make valuable reference matter.

Electric-Railway Fares

STUDIES IN THE COST OF URBAN TRANSPORTATION SERVICE—By F. W. Doolittle, Director, Bureau of Fare Research, American Electric-Railway Association. New York (8 West 40th St.): E. B. Burritt, Secretary of Association. Cloth; 6x9 in.; pp. xii + 467; 56 illustrations. $3.50.

A couple of years ago the American Electric-Railway Association established its Bureau of Fare Research to continue more rapidly and uninterruptedly the studies that had been carried on in the past by certain of its committees. The author of the book in hand became the director of this bureau and its chief worker; from time to time there appeared in *Aera*, the official association paper, and in *Electric Railway Journal* various articles by him on the collection of traffic and cost data for street railways, comparative operating results of American roads, etc. Those occasional papers now appear to have been parts of a comprehensive plan, for they have been gathered up in this volume with such connecting and extending matter as is required by the title.

The book, in effect, is essentially an argument for the cost-of-service theory in making street-railway rates and an exposition of the ways in which the cost of carrying passengers over various parts of a system may be fairly approximated. If the explained measures be followed, there would result a general adoption of something like the European small-fare zones—or perhaps better, like the scheme used in Milwaukee, of a central 5c. zone and outlying 2c. zones, all fixed by the cost of carriage on the several lines. The returns on capital in the electric-railway industry appear to be so meager (averaging 4.9% on bonds and 2.6% on stock, according to the 1912 United States census) that the managers would evidently welcome any practical change that would give them cost plus a profit—leaving to academic halls all discussions of roseate dreams of fares based on "value of service."

So long as this book is an official manual of the organized industry and a natural part of its normal propaganda, by many it will be regarded with suspicion. But although necessarily more or less partisan, nevertheless it should be of great use, inside the industry and out, for it is well conceived, is broad in scope and employs data from regulating commissions, government bureaus, independent engineers and economists, as well as from the officials of supporting railways. A tremendous amount of matter has been squeezed into small space by use of small type—so small as to discourage reading except by those vitally interested.

The book opens up, under the chapter heading "Creating the Street Railway," with a statement of how overhead costs—intangible values—are brought about. Where the nickel goes to is shown by a review of census and company reports on operating and fixed charges, etc. The upward trend of labor and of all railway operating costs is compared with price movements in general. Matters of valuation and depreciation are briefly dismissed with a statement of the theories of utility value—market, sacrifice, agency—and the need of securing cost of replacements from earnings.

A considerable section is occupied by discussions of the peculiarities of street railways as operating utilities, the difficulties of intelligently comparing unit figures, the collection and use of traffic data prior to finding real cost of service and fair operating standards. Methods are shown for computing the effect of proposed line extensions on cost and revenues, the profitable length of haul on various parts of a system and the related matter of widths of possible small-fare zones.

After reviewing the detailed costs of competing forms of city-transit service the author comes to the comforting conclusion that the electric railway is in the most advantageous position and that the jitney bus, once saddled with all the tax burdens it creates, cannot continue in importance. One long chapter shows wherein the riding habit of a city has been more influenced by various local conditions than by any changes of street-car fare—up or down. The final chapters of the volume give the varied details of operation in Cleveland and Milwaukee—the 3c.-fare and the zone-system cities which stand unique among American municipalities in their departures from common practice.

Iron and Steel Analysis

REVIEWED BY ROBERT JOB*

THE SAMPLING AND CHEMICAL ANALYSIS OF IRON AND STEEL—By O. Bauer and E. Deiss, of the Royal Testing Bureau at Gross-Lichterfelde, Germany. Authorized translation from the German by William T. Hall and Robert S. Williams, Massachusetts Institute of Technology. [International Chemical Series.] New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. xiv + 373; 173 illustrations. $3. net.

The object of the translators in bringing this useful work to the attention of American chemists has been to emphasize the extent of segregation in iron and steel and place those in charge of sampling upon their guard against errors which may easily occur unless precautions are taken. Photographs show the variations in composition and in structure which may be expected in iron or steel, and methods of analysis are given in detail, showing both German and American practice. The translation is placed in the International Chemical Series by Dr. H. P. Talbot, of the Institute of Technology, as Consulting Editor.

Unfortunately for the chemist, the sampler too often has little or no idea as to the wide differences in composition and in structure that are frequently found in a piece of metal within a very limited area, and in consequence those called upon to make analyses of samples thus taken obtain results that may be misleading and cause loss. This lack of knowledge upon the subject unfortunately does not stop with the sampler, but in too many instances extends to the works' manager and leads at times to misstatements and bad practices which result at the very least in great confusion.

The authors of the work give a good description of apparatus used in metallographic work, with clear directions as to procedure. In most cases the best standard practice is given, though in the directions for sulphur prints we miss the usual procedure of taking prints directly upon photographic paper instead of upon silk.

The commoner microscopic constituents of iron and steel are shown clearly by means of typical photomicrographs, so that even those who have not made a special study of the microscopic structure of iron and steel find much to interest and to instruct. As a matter of fact, comparatively few persons think of steel as a metal of complex structure, though such is the case, and one often finds as a result of study of the microscopic constituents that a clue is given which enables one to state

*Vice-President and Director of Laboratories, Milton Hersey Co., Ltd., 84 St. Antoine St., Montreal, Canada.

definitely the cause of what otherwise would be termed a mysterious failure of steel. A description, with characteristic etchings, is also given of the "macroscopic" appearance of iron and steel—that is to say, the etched appearance of larger sections of the commercial forms, such as ingots, bar iron and rails.

The larger portion of the book is taken up with the details of methods of analysis of iron, steel and of various materials used in the manufacture of steel, and as a whole this portion of the work will be found of decided interest to the analyst, not merely through the placing of various methods in convenient form for reference, but also by enabling one to compare easily German and American practice. In some cases the former is cumbersome as compared with our quicker and equally accurate methods, as for instance, the Corleis' chrome sulphuric acid method for determination of carbon in steel, as compared with the direct combustion in the electric furnace.

Under the methods for manganese the persulphate method which is in use in most American mills is not given, but works' chemists who have occasion to use routine methods can find the details readily in the yearbook of the American Society for Testing Materials or in other books of reference.

The book will be of value in any laboratory or mill, especially owing to the timely reference to the importance of correct sampling.

On Military Engineering

MILITARY PREPAREDNESS AND THE ENGINEER—By Ernest F. Robinson, Assoc. M. Am. Soc. C. E., Captain, Corps of Engineers, N. G. N. Y. New York: The Clark Book Co. Cloth; 4x7 in.; pp. 224; 75 illustrations. $1.50.

The interest that civilian engineers, all over the country and of all grades of responsibility, are taking in military science has been marvelously demonstrated by the multiplication of organizations for lecture and reading courses, practice drills, etc.; but fully as many interested engineers are not in or close to large centers and hence are somewhat at a loss to know how to approach self-preparation for military-engineering service. This book is designed to help such men; it will do that, and it will also serve those who sit in lecture halls or thumb military texts. For the one class it is a good primary text, opening up the field and orienting the would-be officer's ideas; for the second group it gives better notes on the lectures and elementary texts than even a careful student would make.

It is not, and makes no pretense to be, the be-all and end-all of patriotic preparation. At the outset the author divides engineers in warfare into those in the advanced zone and those in the communication zone—the latter men retaining practically all the characteristics of engineers in civil life. The activities of men in the advanced zone alone are discussed. Various ways open for securing military training are explained—naturally with a strong plea to support the National Guard. Then the organization of the United States Army is sketched, and the important administrative duties of an officer are explained. Why volunteer troops have too often slept supperless is one of the interesting little points here—and is one reason for including this chapter.

Duties, organization and equipment of engineer troops in the field are quickly disposed of. A chapter is interjected on teaching men to shoot and on the effect of various fires. The need, layout and practical construction of field fortifications (trenches, parapets, gun emplacements, obstacles, etc.) are presented, and then mapping and mining offense. A lecture on high explosives, by Prof. M. C. Whitaker, of Columbia University, is placed before notes on demolitions. The chapter on bridges opens with military loads, pictures various knots and hitches and shows spar and pile structures; but it spends the most of its space, naturally, on ponton crossings and American ponton equipage. The final technical discussion of the little volume is a review of topographical mapping. The book draws to a close with a brief exposition of the need for engineers in war and for a last time dwells on the truism that adequate personal military training is a first requisite. Appendix I reprints the Chief of Engineers' reading list for interested civilians (given in *Engineering News*, Mar. 16, 1916). Appendix II shows a list of engineering property carried in the field by an engineer company.

Theory of the Universe

THE UNIVERSE AND THE ATOM: The Ether Constitution, Creation and Structure of Atoms, Gravitation and Electricity, Kinetically Explained—By Marion Erwin, C. E. New York: D. Van Nostrand Co. Cloth; 5x8 in.; pp. 314; 58 illustrations. $2.

This is a most unusual book and comes from a most unusual source. The author presents a theory of the constitution of matter and energy and of the entire physical universe, basing his theory on the principles of mechanics. The conclusion which he reaches as the results of his research is that the celestial bodies—suns, stars and worlds, floating through space—are not limited in number and extent, according to the belief hitherto generally held, but are actually infinite in extent.

The vastness of this conception leaves one breathless, but the author supports it by extended discussion based on the researches of the most eminent scientists. It will be manifest that to prove a proposition of such stupendous magnitude within the comparatively narrow limits of the volume before us would be extremely difficult. The author very frankly says that a book could be written on almost every subject treated in the several chapters. He has attempted to present only the principles that underlie his fundamental proposition.

The reviewer makes no pretense of passing an opinion here on the soundness of the theory which Mr. Erwin has presented. The subjects treated in his book have long been fascinating topics for speculation by scientists everywhere, and his theories and conclusions will doubtless receive careful study from those competent to analyze them.

It is of no small interest to the readers of *Engineering News* to observe that, while the author of this book is an eminent attorney, he graduated from college with the degree of Civil Engineer; and he intimates in his preface that it was his college studies in science and mathematics that aroused interest in original research and led him into the train of studies of which this book is a result. As evidence that the author combines ability in his own profession with his interest in physical science, it is of interest to record that some 15 years ago he was United States District Attorney at Savannah, Ga., and upon him fell the responsibility for conducting the prosecution of Gaynor and Greene, the contractors for river and harbor work in the Savannah district who conspired with ex-Captain Oberlin M. Carter in the late 90's to defraud

the United States. It was largely due to Mr. Erwin's ability and energy in the prosecution of this case that after years of battle in the courts, not only were the contractors convicted and sentenced, but a large part of the funds which Carter had dishonestly secured was recovered by the Government.

New Jersey Riparian Rights

WATERWAYS OF NEW JERSEY: History of Riparian Ownership and Control Over the Navigable Waters of New Jersey—By Charles S. Boyer, Formerly Member of New Jersey Harbor Commission. Camden, N. J.: Sinnickson Chew & Sons Co. Cloth; 6x9 in.; pp. 295; illustrated. $2 postage prepaid.

This book contains the results of extensive research with reference to the ownership and control of navigable waters in New Jersey. To determine the title to riparian lands in the state it is often necessary to go back to the records of original proprietorship, and the first part of the book is taken up with an interesting review of colonial history and the successive and conflicting grants of lands within the state. The author reviews also the history of the state boundary lines and controversies which have taken place in connection with them. In the chapters headed "Rights and Titles to Riparian Lands," "Alluvion," or land formed by the deposit of material in a body of water, and "Federal Authority Over Navigable Waters" the author presents a terse review of the law on these subjects in a way that is intelligible to anyone and may be useful to many engineers. The principal New Jersey waterways described in the book are the old Delaware & Raritan and Morris canals, the Inland Waterway, or channels through the salt marshes parallel with the coast, and the proposed ship canal across New Jersey, for which the Federal Government has made surveys. While the book relates primarily to New Jersey, it contains material of interest to any engineer who may have to look up the legal status of a project involving riparian rights.

Kidder's Pocket-Book Revised

THE ARCHITECTS' AND BUILDERS' POCKET-BOOK: A Handbook for Architects, Structural Engineers, Builders and Draftsmen—By the late Frank E. Kidder, author of "Building Construction and Superintendence." Compiled by a staff of specialists, Thomas Nolan, Editor-in-Chief, Professor of Architectural Construction, University of Pennsylvania. Sixteenth edition, rewritten. New York: John Wiley & Sons. Flexible leather; 4x7 in.; pp. xxiii + 1,816; illustrated. $5 net.

The "Architects' and Builders' Pocket-Book" was first published under the authorship of the late Frank E. Kidder in 1884 and went through 14 editions under the author's direction up to 1904. After Mr. Kidder's death a fifteenth edition was published, including some new matter mainly on fireproofing of buildings and reinforced concrete, and now appears the sixteenth edition, entirely revised and rewritten. This latest edition, produced under the direction of Thomas Nolan, Professor of Architectural Construction, University of Pennsylvania, as editor-in-chief, follows fairly closely the general plan of the original handbook, but is an entirely new publication, both mechanically and editorially. The plan originated in the "American Civil Engineers' Pocket-Book" of having different specialists write on their particular subject has been followed.

These specialists and the general titles of their subdivisions are as follows: Thomas Nolan, "Terms Used in Architectural Engineering," "Masonry Walls, Footings for Light Buildings, Cement and Concrete," "Strength of Brick, Stone, Mass Concrete and Masonry"; Daniel E. Moran, "Foundations"; G. T. Snelling, "Retaining Walls, Breast Walls and Vault Walls," "Stability of Piers and Buttresses," "Stability of Masonry Arches"; Malverd A. Howe, "Forces and Moments," "Types of Roof Trusses," "Stresses in Roof Trusses," "Design and Construction of Roof Trusses"; Charles F. Warren, "The Action and Bending Moments for Beams," "Properties of Structural Shapes, etc.," "Strength of Columns, Posts and Struts, etc.," "Stiffness and Deflection of Beams," "Strength of Beams, etc.," "Strength and Stiffness of Continuous Girders, etc.," "Riveted Steel Plates" and "Box Girders"; H. C. Berry, "Resistance to Tension," "Properties of Iron and Steel," "Resistance to Shear," "Riveted Joints, Pins and Bolts," "Bearing Plates and Bases for Columns, Beams and Girders," "Brackets on Cast-Iron Columns"; F. H. Kindel, "Strength of Beams," "Strength of Built-Up, Flitched and Truss Wooden Girders"; A. P. Stradling, "Wooden Mill and Warehouse Construction"; Rudolph P. Miller, "Fireproofing of Buildings and Reinforced-Concrete Construction"; E. G. Perrot, "Reinforced-Concrete Factory and Mill Construction"; N. A. Richards, "Wind Bracing for Tall Buildings"; R. C. Carpenter, "Heating and Ventilation," "Heat, Fuel, Water, Steam and Air"; J. J. Cosgrove, "Hydraulics, Plumbing and Drainage," "Gas and Gas Piping"; W. H. Timbie, "Lighting and Illumination of Buildings," "Electric Works of Buildings"; Wallace C. Sabine, "Architectural Acoustics."

This enumeration of authors and subjects is quite sufficient to indicate the breadth of the treatment. So far as can be judged from a casual inspection, the method of discussion is very good. The book has undoubtedly been greatly improved in its revision and now constitutes a valuable reference not only for architects, but also for engineers, particularly those engineers who are concerned with any kind of building work—which indeed embraces practically all of the profession.

Concepts of Electric Theory

THE PRINCIPLES OF DYNAMO ELECTRIC MACHINERY—By Benjamin F. Bailey, Professor of Electrical Engineering, University of Michigan. New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. xv + 314; 222 illustrations. $3 net.

Professor Bailey has apparently found the fairly common trouble of students seeming to grasp certain details of electrical theory while not comprehending the fundamental physical concepts involved or the inter-relations of actual phenomena taking place. It is to be presumed that he has had considerable success in evolving teaching methods that prevent such a lamentable condition in his school and that this text shows them.

Throughout the book, evident attempt has been made, first, to describe the fundamental phenomena involved in the operation of the various common pieces of commercial electric machinery and then to outline the more important physical reactions of the apparatus. Naturally, the mathematical development of theory has been given a secondary place, though the shorthand notation furnished by mathematical formulas has been freely employed. The students who are to use this book, or to follow courses based on such procedure, must have a thorough grounding in elementary physics, including

mechanics, for the text does not go back to quite the most rudimentary basis. The book is not to be thought of as a treatise for the "practical" man—the mechanic; in spite of its dealing with definite realities of commercial equipment it does not (nor should it) get down to touch the actual bolts and nuts, collector rings and commutator bars, rubber insulation and iron cores in a way to appeal to anyone but the young technical student or his teacher.

There is, first, the general matter on magnetism, current, resistance, etc. Then some preliminary notes on motors are followed by an outline of electrical distribution systems, old and new. Direct-current generators and motors are taken up again and more in detail, with interjected chapters on accessories and measuring instruments. This uses up a little less than half the book, the rest of which is devoted to alternating currents. Much the same procedure is followed there too, general definitions being followed by properties of circuits, instruments, distribution systems, transformers, synchronous and induction motors and generators, rotary converters and commutating motors.

American Railway Statistics

RAILWAY STATISTICS OF THE UNITED STATES OF AMERICA for the Year Ending June 30, 1915, Compared with The Official Reports for 1914 and Recent Statistics of Foreign Railways—Prepared by Slason Thompson. Chicago: Bureau of Railway News and Statistics. Paper; 6x9 in.; pp. 147.

This is the twelfth annual issue of this book of railway statistics. The compiler of these statistics, Mr. Thompson, is the avowed advocate and defender of the railways, but the statistics he presents are none the less interesting and convenient, especially as he furnishes statistics on a great variety of railway matters which one would have to hunt through many official documents to gather for himself. Of special interest just now, in view of the demands upon the railway companies made by the railway trainmen, are the statistics regarding employees' compensation. It appears from these tables that enginemen, whose average pay was $3.68 in 1892, received in 1914 $5.24. Railway brakemen and flagmen, whose average daily pay was $1.89 in 1892, received $3.09 in 1914. The pay of railway yardmen, on the other hand, has remained almost stationary. Switchmen, flagmen and watchmen received $1.78 per day in 1892 and $1.71 per day in 1914. Railway employees of all classes in the year ended June 30, 1915, numbered 1,542,000, and their average annual compensation was $825. It is interesting to compare these annual earnings of railway employees in the United States with those of railway employees in other countries. Mr. Thompson gives the following figures for the average earnings of railway employees in the principal countries of Europe: United Kingdom, $279; German Empire, $409; Austria, $330; Russia, $211; France $260; Switzerland, $368; Japan, $113.

It is fair to say that these figures, while the latest obtainable, are in some cases several years old, and Mr. Thompson states that war conditions and the increased cost of provisions have compelled an advance in railway wages in the principal countries of Europe.

An idea of the scope of the book may be gained from headings of some of the principal chapters, as follows: Railway Mileage in 1915; Equipment; Employees and Compensation; Capitalization; Cost of Construction; Ownership of American Railways; Public Service of the Railways; Locomotive Fuel; Accidents; Cost of Railway Regulation. Under the head of "Recommendations" Mr. Thompson says:

> If regulation of American railways is to continue along the present lines of subordinating the transportation necessities of a continent to the petty interests of individual shippers, the sectional jealousies of states and the rivalry of communities, nothing in the way of temporary relief can save it from the inevitable collapse into the incompetent hands of the state.

Design of Masonry Dams

MASONRY DAM DESIGN; Including High Masonry Dams—By Charles E. Morrison, C. E., Ph. D., Formerly of the Civil Engineering Department of Columbia University, and Orrin L. Brodie, M. Am. Soc. C. E., late Assistant Designing Engineer, New York Board of Water-Supply. Second Edition, revised and enlarged. New York: John Wiley & Sons. Cloth; 6x9 in.; pp. ix + 276; 47 illustrations. $2.50 net.

The first edition of this book (reviewed in *Engineering News*, June 16, 1910), was entitled "High Masonry Dams." The second edition includes practically all of the information in the first and has been amplified to the extent of writing general expressions wherever possible, so that the design of low and medium-size, as well as high, masonry dams may be prosecuted according to the theory and methods developed. Besides, there have been added chapters on overfall dams and arch dams and a long illustrated list of the large masonry dams already built. The first edition has already been accepted as a standard of succinctness and completeness. The second adds very valuable material.

Kutter, D'Arcy and Bazin

REVIEWED BY ROBERT E. HORTON*

HYDRAULIC TABLES FOR THE FLOW OF WATER, in Circular Pipes Under Pressure, Timber Flumes, Open Channels and Egg-Shaped Conduits—By Joseph H. Harper, Civil and Mining Engineer, formerly of Harper, Macdonald & Co., Butte, Mont. New York: D. Van Nostrand Co. Flexible leather; 4x7 in.; pp. 192; 17 illustrations, 22 charts. $2 net.

This is an engineers' pocket-book of hydraulic tables based mainly on the Kutter formula. Tables of the flow in pipes are given for all the usual diameters for a series of eight slopes and for values of n in Kutter's formula of 0.010, 0.012, 0.015 and 0.020. Similar tables are given, based on the D'Arcy formula, for cast-iron pipe, both new and old. The tables are intended to constitute, as the author states, a "grill of solved problems" especially useful for "rough and ready calculations." A similar grill of solutions for special cases is provided for open rectangular channels covering widths from 4 in. to 40 ft. and depths from 2 in. to 8 ft., with six different slopes in each case. There is a table for each of the following values of n in the Kutter formula: 0.011, 0.013 and 0.015. Other tables cover the flow in open trapezoidal channels with side slopes of one on one. For the latter, separate tables are given, based on each of four forms of the Bazin formula and also on Kutter's formula with $n = 0.017$, 0.020, 0.025 and 0.030.

All the tables give velocities in lineal feet per second and discharges in cubic feet per second. The omission of quantities in gallons per 24 hr. hampers the use of the pipe tables for ordinary water-works calculations.

The tables are neat, concise and convenient in arrangement. They cover, however, rather a limited number of values within a wide range. They should prove very useful in preliminary studies for the comparison of the

*Consulting Hydraulic Engineer, 57 North Pine Ave., Albany, N. Y.

relative carrying capacity of conduits of different materials and slopes. They are accompanied by a discussion of the methods and accuracy of cross-interpolation for different cases. To facilitate accurate interpolation for intermediate slopes, the column heads contain slopes in terms of feet per mile and also the square root of the absolute slope. It seems unfortunate that the slopes in feet per thousand are not also stated.

The book contains many other useful hydraulic tables on orifices, weirs, etc., as well as an interesting discussion of the development of the formulas on which the tables are based.

Carbonization of Coal

REVIEWED BY ALFRED E. FORSTALL*

COAL AND COKE—By Frederick H. Wagner, M. Am. Soc. M. E., Gas Byproduct Lecturer in Johns Hopkins University. New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. xii + 431; 137 illustrations. $4 net.

This book gives a compilation of articles and reports of investigations published during recent years upon various subjects connected with the carbonization of coal.

Under the heading Coal are treated the origin and varieties, the theory of spontaneous heating and combustion, the analysis and the storage of that material, together with the characteristics of coking and gas coals.

Under Coke are included carbonization for the production of gas in horizontal, inclined and vertical retorts and chamber ovens and for that of coke in beehive and byproduct ovens; the general principles of the gaseous combustion of solid fuel; the relative merits for coal-carbonizing plants of an individual producer for heating each bench of retorts or of a central plant of Kerpely producers each unit of which serves a number of carbonizing units; the heat balance of carbonization in retorts; low-temperature carbonization; the utilization for producing steam of the heat still remaining in the flue gases when they leave the recuperators or regenerators; and the quenching, screening and loading of coke at byproduct oven plants.

The descriptive matter is plentifully illustrated by cuts and plates. The author seldom gives his own opinion, and some discrepancies and inaccuracies were noticed which show lack of careful reading of the matter used. One instance of this, which is apt to mislead the reader unfamiliar with the subject, credits the Koppers ovens in Vienna with a gas-making capacity nearly ten times too large. The book, however, by means of its full résumé of recent literature, gives a good general treatment of the subjects covered.

Wood for Building

STRUCTURAL TIMBER BULLETINS. Timber for Structural Purposes—By E. A. Sterling. Engineering Bulletin No. 1. Chicago: National Lumber Manufacturers Association, Trade Extension Department.

In the first of a series of monographs on structural timber E. A. Sterling brings together a group of interesting facts bearing on permanence, cheapness and other advantages of wood for building. Fire-retardant paints and dips are mentioned, but they are to be treated fully in a separate bulletin soon to issue. On the question of cost the author shows that lumber is cheaper than it was 40 years ago.

*Forstall & Robison, Consulting Engineers, 84 William St., New York City.

Scale-Tables for Quantities on Railway Construction

LEVEL SECTION TRANSPARENT SCALES FOR PLATE "A" PROFILES, for Graduation, Arch Masonry and Iron Culverts—By F. W. Steber. Dallas, Tex. (2101 McKinney Ave.): The Author. Leather; 3x9 in. $2.50.

F. W. Steber has produced an entirely new device for quickly estimating railway-construction quantities. It consists of a book of transparent strips bearing scalar tables to the vertical scale of plate A profile paper, which when laid on the profile enable the user to read off the earthwork quantity per station or the amount of culvert masonry or the weight of culvert pipe, corresponding to the center height. The center heights need not be scaled, but give the quantity readings by their intersection with the column of quantity figures.

The tables of earthwork per 100-ft. station are given separately for three slopes—namely, $\frac{1}{2}$:1; 1:1 and $1\frac{1}{2}$:1. Auxiliary tables enable corrections for roadbed 2 ft. wider or for breaks in the side slopes to be read off in a single additional reading.

Each sheet is printed on transparent celluloid. The size of the leaves, $2\frac{3}{4}$x$8\frac{3}{4}$ in., and their arrangement in a book by pinning them together at one end enable any one sheet to be turned to place in a moment and applied directly to the profile of the line.

The author remarks that, since the determination of quantities from center height is apt to give results slightly lower than either mean end area or prismoidal calculations, there is a slight compensating advantage in the shrinkage of the celluloid, as this increases somewhat the quantities read from the tables.

The scales were made by photographic reduction on large layouts and are therefore considered to be accurate.

British Health Work

ENGLISH PUBLIC HEALTH ADMINISTRATION—By B. G. Bannington, Inspector of Nuisances, County Borough of West Ham. London: P. S. King & Son, Ltd. [Studies in Economics and Political Science.] Cloth; 6x9 in.; pp. 338. 7½s.

Such a comprehensive survey as this is sure to be welcomed and appreciated by American students of comparative government and of local and state health administration, although of course the book is of far more direct practical use in England than in the United States. A considerable amount of space is given to various sanitary and town-planning matters and to the control over health and sanitation exercised by the Local Government Board.

German Wireless Telegraphy

WIRELESS TELEGRAPHY—By Dr. J. Zenneck, Professor of Physics at the Technical High School of Munich. Translated from the German by A. E. Seelig. New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. xx + 443; 469 illustrations. $4 net.

Heretofore a knowledge of the details of German wireless-telegraph systems and apparatus has been easily secured only by those who were able to read some of the German texts—like Zenneck's own, which appear to have been highly regarded. The gap is now bridged by a translation of his well known "Lehrbuch." The translator, in making the change of tongue, has preserved the author's idioms by literal rendering wherever there was any chance that ordinary English phrases would not accurately convey the original meaning; as the preface states, he has preferred "to let Zenneck be Zenneck." It remains to be seen whether the readers will grasp Angli-

cized Zenneck better than they would translated Zenneck. The book of course is not merely a discussion of certain radio-telegraphic systems and apparatus, but a genuine treatise on the science and art of radio-telegraphy. The reader is assumed to have considerable technical training—a working knowledge of calculus and electrophysics.

The text first opens up with the topic of oscillations in circuits having capacity and inductance, and expands the treatment to cover the larger external electromagnetic and static fields. The next group of chapters deals with the properties of high-frequency circuits. Closer attention to equipment naturally comes in the sections on antennæ and aërials, transmitters, receivers and detectors, though the descriptions of apparatus are interrupted to discuss the propagation of waves over the earth and the directing of impulses. There is a brief chapter on wireless telephony. A particularly full bibliography is appended.

Mead's Water Power Revised

WATER POWER ENGINEERING: The Theory, Investigation and Development of Water Powers—By Daniel W. Mead, M. Am. Soc. C. E., Professor of Hydraulic and Sanitary Engineering, University of Wisconsin. Second edition. New York: McGraw-Hill Book Co. Cloth, 6x9 in.; pp. xvii + 843; 430 illustrations. $5 net.

The first edition of this book was highly regarded by most of those who used it as a guide into the mysteries of hydraulic power-plant design. The author frankly admits that the work had some important shortcomings. He therefore set himself to improving the book when the second edition became possible. As a consequence, the new volume is materially different from the first. The book is still unprepossessing in its make-up; the wallpaper end sheets, the crowded text, the Roman-type formulas, the many styleless line cuts and indistinct halftones, all conspire to give the volume a handicap that it does not deserve. Ten years ago the artistic engineering text had not been developed and these features would have aroused no comment; their persistence today in an important book like this calls attention to the progress that has been made.

The new edition contains no general discussions of hydraulics as a separate science, it being assumed that the reader is versed in its elements and applications. Hydrology, too, has been largely omitted (to appear in a later volume we are told). The study of turbine design (by means of efficiency-contour diagrams, etc.) has been strengthened until it is more easily grasped and more nearly meets the needs of engineers selecting waterwheels. The chapter bibliographies have been brought up to date more nearly—though there still are some instances of haphazard accumulation.

The author's historical notes on water power and waterwheels, particularly the latter, will appeal to anyone who has had to search for such material. The development of all the wheels is more specifically portrayed than in the books on wheels and turbines alone.

The text starts out with some historical notes, and shortly switches over to efficiency of machines and plants. There are notes on plant-load characteristics, stream flow and its changes, flow measurements, use of hydrographs. Then the author reverts to history—that of the better-known types of apparatus. A long section takes up the graphical analysis of turbine design, and after that goes into penstock and flume design. All the present-day apparatus makers appear to have been permitted to file a brief giving their progress—not a bad idea either. Descriptions of typical or notable plants are following an outline of dam construction. Finally, there are sections on costs of plants and output, financial and commercial aspects of hydro-electric plants, procedure in making of projects, and tables of important Holyoke Flume Tests on various runners, to show progress through the years.

Steinmetz "Elements" Revised

THEORETICAL ELEMENTS OF ELECTRICAL ENGINEERING—By Charles Proteus Steinmetz. Fourth edition, thoroughly revised and entirely reset. New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. xiii + 268; 184 illustrations. $3 net.

One of Steinmetz's best-known works on electrical engineering is his "Theoretical Elements of Electrical Engineering," which was originally written in 1901, and in 1915 ran through its fourth edition. The great expansion of the art and science in this period had brought so many actual and proposed additions to the text that it was found impossible to continue the issue of this work and its companion, "Alternating Current Phenomena." A radical rearrangement, therefore, has been started of both volumes. It is planned to withhold part of the material finally available for these two volumes and to incorporate this in a third member of the series.

The present volume, as would accordingly be expected, treats only the most fundamental matters of electrical engineering—such as magnetism, current, electromotive-force generation, properties of circuits, actions in synchronous-, induction- and commutating-type machines, vector diagrams, etc. The detailed treatment is that made familiar for several years by the author and needs no discussion here. There is one notable change, however—the substitution of the standardized "crank diagram" of vector representation for the author's preferred polar diagram, which gives an apparently anti-clockwise vector rotation. Notwithstanding the greater applicability of the polar diagram, the crank diagram is in greater favor for elementary books, and the author has recognized the confusion induced by non-uniformity among the leading texts.

Progress of Good Roads

GOOD ROADS YEAR BOOK, 1916—Fifth Annual Edition. Washington, D. C.: American Highway Association. Cloth; 6x9 in.; pp. 440. $1 per copy, $4 for five copies.

The first 180 pages of this useful annual are devoted to road legislation, etc., in the United States and Canada. Taking New York as a sample, there is given first a review of legislation relating to state-aid, local roads and bonds, convict labor, civil-service law applicable to road officials, automobile registration, list of highway officials, progress reports, road funds and publications issued. The information given for each state has been approved by the state highway engineer or highway commissioner or some other responsible official. A valuable feature of the book is the digest of state-highway specifications for water-bound macadam and telford, bituminous, brick, concrete and gravel roads. Much space is given to highway bonds, and there is a long series of tables for use in computing sinking funds, annuities, etc. Some idea of the extent of the good-roads movement may be gleaned from the fact that over 40 pages of the book are devoted to listing the various road-improvement associations—national, state and local.

Some Municipal Statistics

GENERAL STATISTICS OF CITIES: 1915—Including Statistics of Governmental Organizations, Police Departments, Liquor Traffic and Municipally Owned Water-Supply Systems in Cities Having a Population of Over 30,000. [Prepared under the supervision of Starke M. Grogan, Chief Statistician in Charge of Finance and Municipal Statistics; Arthur J. Hirsch, Chief of Division; and Lemuel A. Carruthers, Expert Special Agent.] Washington, D. C.: Bureau of the Census, Samuel L. Rogers, Director. Cloth; 9½x12 in.; pp. 185; one map.

For promptness of publication compared with many earlier Census reports this volume deserves commendation. The figures for the 204 cities and towns included are for department years ended from July 1, 1914, to June 30, 1915. True, this makes some of the figures nearly two years old when published (about May 1), but with such a variety of fiscal years as prevails and all the other difficulties hindering the collection of municipal statistics this date is about as early as could be expected. It should be mentioned, however, that promptness has been aided by limiting the contents to the four topics named in the subtitle.

Under governmental organization the readers of these columns will care most for data on the commission and commission-manager plans and for salaries paid to city engineers.

The water-supply statistics include date built or bought and estimated value of system; sources and modes of supply; kind of power used for pumping; kind, amount and cost of water purification; miles of mains; number of fire hydrants and meters; per cent. of water metered and per capita consumption. In addition, flat and metered schedules of water rates are given for the 155 cities owning their works.

Considering the limited range of the water-works statistics, it is a pity that some relatively useless figures are given. Of what importance are the figures giving number, depth and diameter in inches of wells? Of more possible value is the separate presentation of four columns of figures for coagulation; but space and labor could have been saved by a simple statement that all water passing through mechanical filters receives a coagulant, and a few footnotes would have taken care of the other instances of coagulation. A serious omission is the number of taps or services in the table that gives meters, per cent. of water metered and per capita consumption. This one omitted column would have been worth more than the three on wells and perhaps more than the whole seven to which exception has just been taken.

British Telephone Text

THE TELEPHONE AND TELEPHONE EXCHANGES; Their Invention and Development—By J. E. Kingsbury. New York: Longmans, Green & Co. Cloth; 6x9 in.; pp. x + 558; 180 illustrations. $4 net.

If this book were seriously intended for sale in America, it would be carrying "coals to Newcastle," for it leans heavily on American publications for information on an American invention which, in its service, has been more highly developed here than anywhere else. The work is voluminous and not particularly easy reading, since the author has proceeded largely on the scheme of presenting extracts from original papers rather than to digest them for his own story. Such a work, it should be noted, is undoubtedly of much greater value abroad than American readers will readily appreciate—due of course to the greater familiarity here with, and the accessibility of, historical papers on the telephone.

The author gives first some of the attempts that preceded Bell's and then the details of his progress and final success. As might be expected, the larger part of the book is descriptive of the evolution of the modern exchange system—as individual pieces of apparatus and as assembled equipment. Finally the book discloses the development of rates, effects on industry and government control and ownership. Data on the telephone development of important world cities are appended, as of Jan. 1, 1914.

NEW PUBLICATIONS

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale and the price is known by the editor, the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be secured without cost, at least by inclosing postage. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or in case of books or papers privately printed, then to the author or other person indicated in the notice.]

AMERICAN PUBLIC HEALTH PROTECTION—By Henry Bixby Hemenway, A.M., M.D., author of "The Legal Principles of Public Health Administration," etc. Indianapolis, Ind.: The Bobbs-Merrill Co. Cloth; 5x8 in.; pp. 283. $1.25 net.

CIRCULAR COVERED SERVICE RESERVOIRS—By William Morris, M. Inst. C. E. [Excerpt, Minutes of Proceedings of the Institution of Civil Engineers, Session 1914-15, Part I.] London, England: The Institution. Paper; 6x9 in.; pp. 15; 11 illustrations.

CONCRETE ON THE FARM AND IN THE SHOP—By H. Colin Campbell, Contributing Editor to the "Cement World" and "American Carpenter and Builder," Member of Editorial Staff of "Farm Engineering." New York: Norman W. Henley Publishing Co. Linen; 5x7 in.; pp. 149; 51 illustrations. 75c.

EXPLOSIVES FOR SHALE AND CLAY BLASTING—Wilmington, Del.: E. I. du Pont de Nemours Co. Paper; 6x9 in.; pp. 38; 31 illustrations.

FIRST REPORT OF THE COMMITTEE ON CIVIL SERVICE OF THE SENATE OF THE STATE OF NEW YORK, 1916—Albany, N. Y. Cloth; 6x9 in.; pp. 933.

FIRST ANNUAL REPORT OF THE PUBLIC UTILITIES COMMISSION, STATE OF MAINE (1915): Vol. I, Relating to Public Utilities—Augusta, Maine. Cloth; 6x9 in.; pp. 445.

INVAR AND RELATED NICKEL STEELS—Washington, D. C.: Bureau of Standards. Circular No. 58. Paper; 7x10 in.; pp. 68; illustrated.

PARKS AND PARK ENGINEERING—By William T. Lyle, Assoc. M. Am. Soc. C. E., Professor of Municipal Engineering at Lafayette College. New York: John Wiley & Sons, Inc. Cloth; 6x9 in.; pp. viii + 130; 38 full-page plates. $1.25 net.

THE PORT OF BOSTON—By Edwin J. Clapp, Ph.D., Professor of Economics, New York University. New Haven, Conn.: Yale University Press. Cloth; 6x9 in.; pp. xii + 402; illustrated. $2.50 net.

THE PRACTICAL DESIGN OF STEEL-FRAMED SHEDS—By Albert S. Spencer. New York: D. Van Nostrand Co. Cloth; 6x10 in.; pp. xv + 163; 13 folding plates. $3.50 net.

PROCEEDINGS OF THE CITY MANAGERS' ASSOCIATION, 1915—Niagara Falls, N. Y.: O. E. Carr, Secretary. Paper; 6x9 in.; pp. 128. 15c.

Consists largely of personal experiences of the various managers in attendance. A list of some 80 city-manager cities with dates when the plan went into operation and names of the managers, is appended.

PROTECTION OF INDUSTRIAL PROPERTY: Monopolies Granted by Governments—By H. A. Toulmin, Jr., Member of the Ohio Bar. [Reprinted from the Virginia Law Review, December, 1915.] Dayton, Ohio: The Author. Paper; 7x10 in.; pp. 16.

QUANTITY OF GASOLINE NECESSARY TO PRODUCE EXPLOSIVE CONDITIONS IN SEWERS—By G. A. Burrell and H. T. Boyd. Washington, D. C.: Bureau of Mines. Technical Paper No. 117. Paper; 6x9 in.; pp. 17; illustrated.

A description of tests and notes on results appeared in our issue of Nov. 11, 1915, page 955.

REPORT OF PROGRESS OF STREAM MEASUREMENTS IN CANADA FOR 1914—Ottawa, Ont.: Department of the Interior of Canada, Irrigation Branch. Paper; 7x10 in.; pp. 508; illustrated. 35c.

STREET-NAME SIGNS—Bulletin 20, Engineering Extension Department, Iowa State College, Ames, Iowa. Paper; 6x9 in.; pp. 48; 38 illustrations.

A unique and interesting monograph, based on information and illustrations collected from all over the United States. Materials, design and color of lettering, supports, heights, locations and other phases of the subject are critically presented. Some cost figures are given.

VALUE FOR RATE-MAKING—By Henry Floy, Fel. Am. Inst. E. E., M. Am. Soc. C. E., Consulting Engineer. New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. viii + 322; illustrated. $4 net.

Field and Office

Waterproofing Cures Expansion That Wrecks Roof

An interesting instance of a tile roof wrecked by thermal expansion and of unusually complete provisions (by waterproofing methods) against repetition of the trouble has been noted in the case of Laboratories A and B of the United States Department of Agriculture, Washington, D. C. Owing to faulty construction the roof tiles (red terra cotta) were laid without any regard to effects of thermal expansion and contraction (Fig. 1). As a result of the longitudinal force developed, the tile were crushed in many places; also the transverse expansion lifted the ridge tile, as shown in Fig. 3. Water penetrated the tile cover and ran down under the copper flashing of the cornice. The leakage into the building grew worse and worse in spite of employing every expedient short of rebuilding the roof. Finally in November, 1915, bids were asked for the waterproofing of the slab and relaying the tile, and contract was let to the Masonry Waterproofing Co., of Brooklyn, N. Y., for a trial section of about an eighth of the roof. This work was completed in December and has proved satisfactory under winter conditions. The sections will be watched through one summer; and if no trouble develops, the entire roof of both laboratories will be relaid similarly.

The tile were stripped off and cleaned; then the roof slab was cleaned to a smooth surface. (This stripping and the later covering were done over small areas so as to have no part of the roof slab open to the weather over night.) Next, a waterproof membrane was laid over the roof slab, the clean concrete being mopped with hot bituminous compound, and saturated sheets of cotton drill, 3 ft. square, being laid down with 2-in. laps. The compound was blended by the contractor so as to secure maximum cohesive and adhesive qualities. This particular use of a thin membrane of maximum plasticity was devised by Oscar Sheffield, Chief Engineer of the contracting concern ("Larutan System").

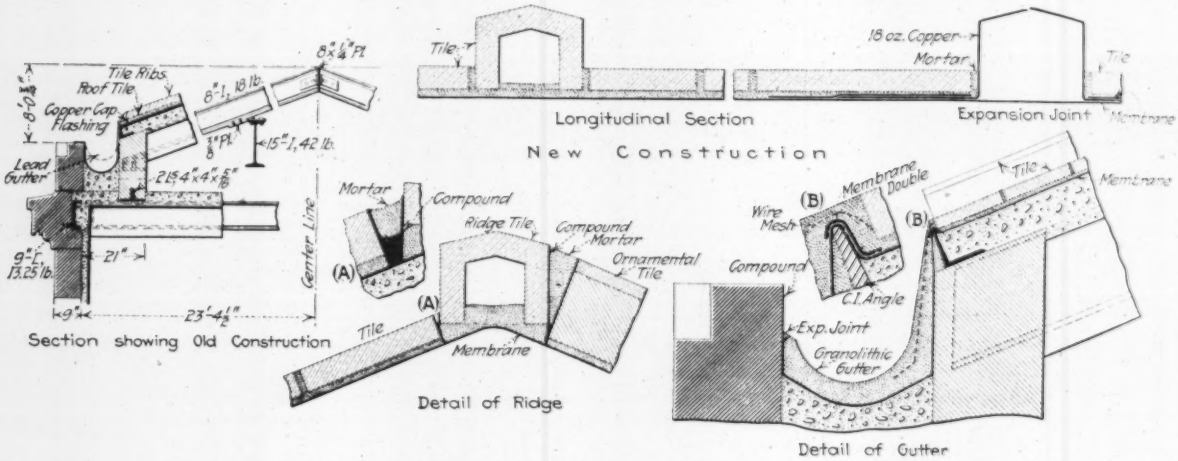
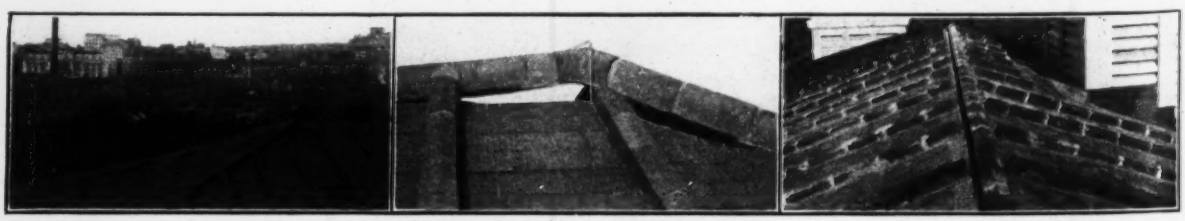


FIG. 1. DETAILS OF ORIGINAL AND RELAID ROOF; AGRICULTURAL LABORATORIES, WASHINGTON, D. C.

The membrane was carried over the angle at the eaves, down around the gutter and part way up the backing stone of the cornice, as shown in Fig. 1. The old copper gutter was removed and the membrane placed directly on the concrete and stone slabs of the gutter.

The tile was relaid, bedded in 2:1 portland-cement mortar, directly on the membrane. The joints were pointed with mortar colored to match the tile. The gutter membrane was covered with 2 in. of granolithic finish, reinforced with wire mesh on the vertical face. At the junction of granolithic gutter with the end of the membrane an expansion joint was used to preserve the seal.

Longitudinally every 50 ft. across the roof an expansion joint was made by replacing a line of ornamental tile with a false tile of sheet copper having flanges extending under the adjacent roof tiles and bedded on the waterproof membrane, as shown in Fig. 1. This



FIGS. 2 TO 4. ORIGINAL AND RELAID ROOF OF AGRICULTURAL LABORATORIES

Figs. 2 and 3 show some of the expansion troubles. Fig. 4 shows in the foreground copper false ornamental tiles

preserved the original appearance of the roof. One of the false copper tiles was similarly used as a sliding-sleeve joint cover in the ridge of the roof opposite each longitudinal expansion joint.

Where the roof and ornamental tile join the ridge tiles, the joint is sealed with compound and a grout plug, as shown in Fig. 1. Below each plug is a small reservoir of compound. As the roof contracts, the plug is drawn down into the bitumen; and as expansion occurs, the plug is forced upward—the seal being preserved under this movement.

Dynamite and Small Bucket Help Deep-Well Sinking

In sinking the deep wells from which Hibbing, Minn., gets its water-supply (as noted in *Engineering News*, Apr. 13, 1916, p. 688) so much difficulty was found with boulders blocking the well casings that a method was evolved of shattering the stones with dynamite and removing the pieces with a small orange-peel bucket in the well casing.

The wells are 24 to 36 in. in diameter, from ¼ to 1½ mi. apart, and are scattered over a glacial deposit of sand, gravel and boulders. The boulders are of hard granite; most of them run in size from 1 to 4 ft. in diameter and are smooth and round. Boulders are not encountered near the surface, as the first 25 to 40 ft. consists of fine sand.

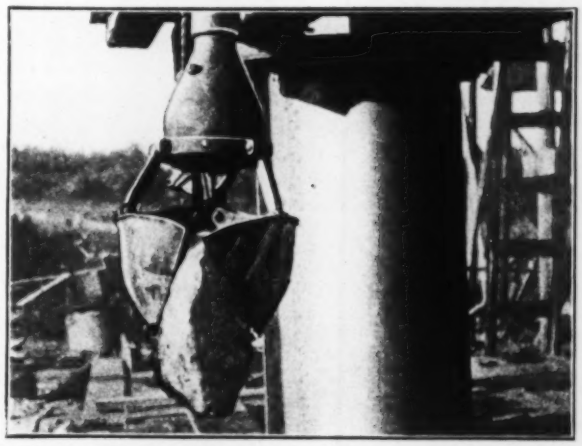
When the boulders were first met with, the drilling rigs were moved a few feet, in the hope of getting through the drift easily. Moving the derricks and resetting the rigs required two or three days, and frequently new boulders were struck.

The contractors then tried shooting. The casing screen was made of ⅜-in. boiler steel to withstand the blasts; on the bottom a ½x8-in. steel band was shrunk on. Occasionally the shots were too deep and heavy, and the screen was so damaged that it had to be pulled and drilling started with new material.

After much experimenting it was found most successful to place small shots against the boulders, an eighth of a stick of dynamite being used about 6 in. below the casing and as close to the rock as possible. Often it was necessary to shoot many times before a boulder would be shattered enough to be taken out through the casing by the bucket. Where a small boulder was not too far under the edge of the casing, it frequently could be shot out and turned over so that the bucket could grab it. For this work it was necessary to use a guide near the bottom to keep the casing straight and then to shoot all the way around the edge of the screen. Some days it would be necessary to set off 150 shots and the day's progress would be only 1 ft. sinking.

When the boulders were so large that an outside shot would have no effect, a hole was drilled in 5 to 8 in. and a small shot set off. A little dynamite thus used would break up any boulder in pieces small enough to be taken out through the casing.

In shooting, the casing was weighted down with a bin 8 ft. square filled with rock. The bucket was a 12-in. plunger orange-peel which had been previously used for bailing out sand, gravel and small stones. The dynamite was of 60% strength. The contractor for the well sinking was the Lane & Bowler Co., of Houston, Tex.,



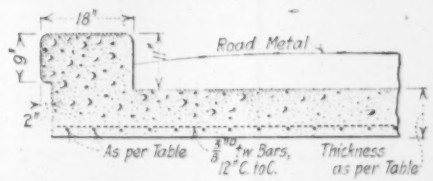
ORANGE-PEEL BUCKET WITH BOULDER
Boulder 9x12x18 in. Depth 45 ft. Casing 24 in.

which firm furnished the well and pumping equipment. Burns & McDonnell, of Kansas City, Mo., handled the engineering features of construction.

Flat-Slab Highway Bridges; Ohio Standards

Concrete-slab bridges of 2 to 20 ft. span on state-aid roads in Ohio will in future be built according to the sketch and table given herewith. The width on which wheel loads distribute is defined by a formula stated in the notes following the table.

STANDARD DIMENSIONS AND REINFORCEMENT FOR FLAT-SLAB CULVERTS AND BRIDGES
(Ohio State Highway Department)



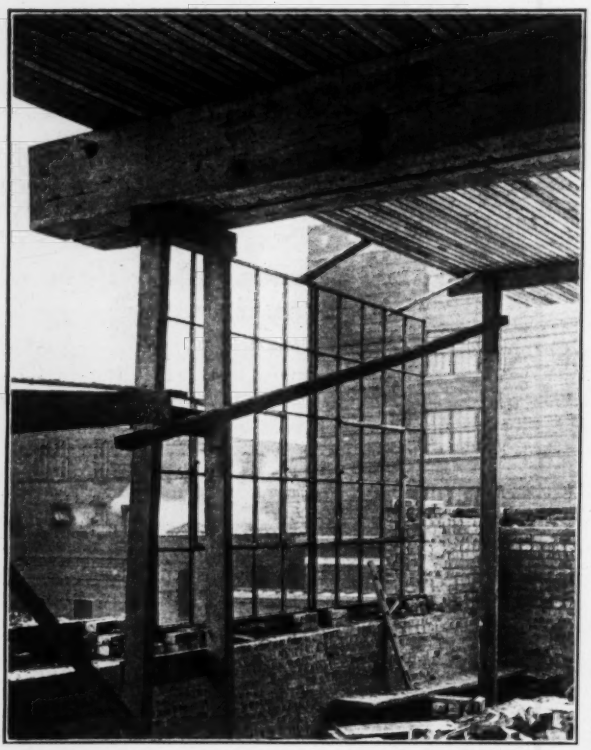
Span, Ft.	Thickness, In.	Spacing of Bars, In. ½ In. Sq.	⅝ In. Sq.	¾ In. Sq.	⅞ In. Sq.	Moment, 1,000 Lb.-Ft.
2	5	6½	...	...	...	2.06
3	6	6	...	...	...	2.82
4	6	5	...	...	...	3.38
5	7	5½	...	...	...	3.80
6	7	5	...	...	...	3.99
7	8	5	7½	...	...	4.74
8	8	4	6½	...	...	5.52
9	9	4	6½	...	...	6.45
10	9	3½	5½	7½	...	7.32
11	10	...	5½	7½	...	8.40
12	10	...	5	7	...	9.38
13	11	...	5	6½	...	10.63
14	11	...	4½	6	...	11.69
15	12	...	4	6	8	13.15
16	12	...	...	5½	7½	14.35
17	13	...	...	5½	7½	16.03
18	13	...	...	5	6½	17.34
19	14	...	...	5	6½	19.28
20	14	...	...	4½	6	20.75

Assumptions: Unit stresses—Concrete, 750 lb.; steel, 16,000 lb. Loads—Dead-load = Weight of slab + 100 lb. per sq.ft.; Live-load = 15 tons on two axles 10-ft. centers 6-ft. gage, two-thirds load on rear axle; Impact = ¼ live-load. Distribution: $p = (42 - 4S)$ for spans of 6 ft. or less, and $p = (20 - 0.4S)$ for spans greater than 6 ft., where p = percentage of one wheel-load which is considered to be carried by 1 ft. width of slab as a concentrated load at midspan, and S = clear span in feet. Bars are to be placed two diameters from center of bar to bottom of slab.

The table was drawn up by John R. Chamberlin, bridge engineer of the State Highway Department, under Clinton Cowen, Commissioner of Highways. It is one of a considerable number of standard sheets for roadwork. This particular table was adopted during the past month.

Erecting Mill-Construction Buildings in Winter

The erection of a building of the timber mill-construction type during the winter is shown in the accompanying view, the placing of the heavy timber framing and floors being carried on even when the weather was too cold for laying brick. The columns and girders for the second and third floors were braced in place, and the laminated flooring was laid upon the girders. The view shows the braced temporary supports at the ends of the girders and the temporary plate installed to carry the ends of the flooring. The structure is a four-story building for the Central Bay Manufacturing Co., the architect for which was S. Scott Joy, of Chicago. It is one of several buildings of the timber mill-construction type which have been built at Chicago during the past winter.



ERECTING THE TIMBER FRAME OF A MILL-CONSTRUCTION BUILDING IN ADVANCE OF THE BRICK WALLS

Sewer and Street Work for New Chicago Union Station

The construction of the new union station at Chicago involves a large amount of preliminary street and sewer work, most of which is done under difficulties incident to busy city streets. Three views of interesting portions of this construction work are shown herewith.

Fig. 2 is a view of the construction of the 12-ft. horseshoe-section outlet sewer, which has to be carried around the station property instead of running across it to the river (*Engineering News*, Feb. 3, 1916). The view is looking north in Canal St., and at the left is the Chicago & Northwestern Ry. terminal station, at Canal and Madison St.

A revolving steam shovel in the trench is making the second cut for the grade of the bottom of the sewer and is loading the material into dump wagons on the street. During part of the work the loaded wagons were driven back over the completed section of the sewer to finish the backfilling and raise the street to its new grade. This part of the street (at the left) is shown at the old grade, but the sidewalk is on the new grade. This sidewalk forms the top of a public-utility gallery (*Engineering News*, Dec. 16, 1915). The concrete wall at the right is the boundary of the station property and was built in a narrow deep trench before the excavation of the trench for the sewer.

Concrete is mixed at a plant north of Madison St. and spouted through a long suspended chute (*Engineering News*, Feb. 3). For some portions it was diverted into branch pipes leading to the forms; for other portions it was delivered to a hopper for loading wheeled carts that were dumped into the funnel heads of flexible telescope pipe chutes. When the work was near the concreting plant, the elevator bucket dumped directly into one of these pipes, which was extended up the tower, while its lower end connected with an inclined open chute or trough.

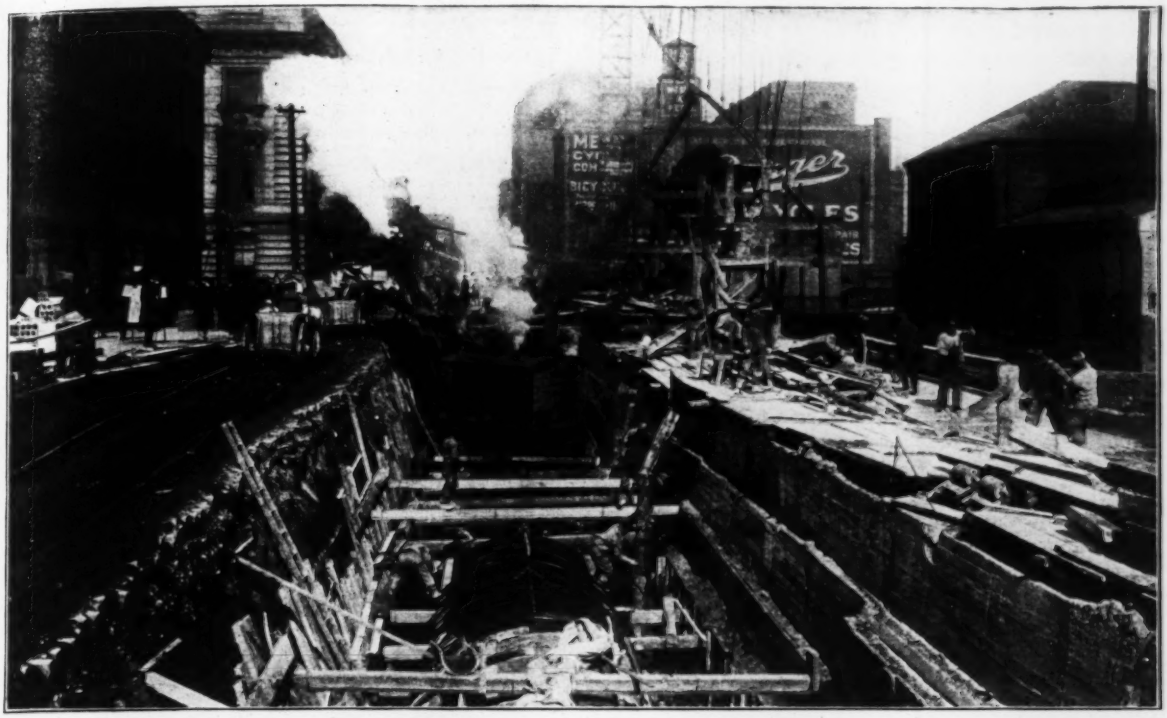
Where the sewer crosses under Madison St., drifts were driven and heavy timbering put in, with steel girders to carry the roadway and car tracks. The sidewalk was carried over the trench by an old plate girder laid on its side. The excavation of the core was done from one side, small steel dump-cars removing the material and dumping it as backfill over the completed part of the work.

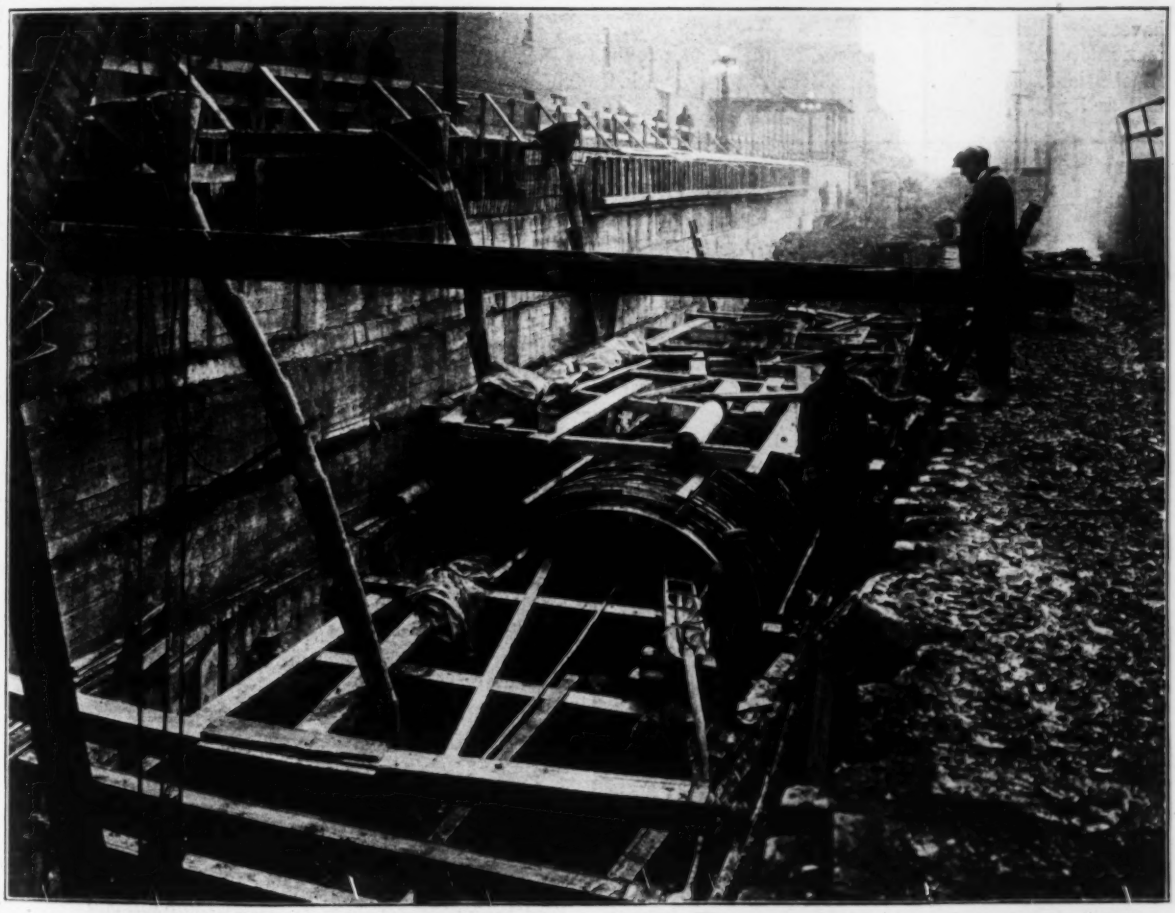
At the right in Fig. 2, where the two men are holding the reinforcing hoop, is the top of an incline (parallel with the street) leading down to the level of the railway tracks in the present union station. This is for express and mail wagons, and a temporary bridge was thrown across the cut to avoid interrupting this traffic.

FIG. 1. RAISING THE GRADE OF CANAL ST., AT THE UNION STATION, CHICAGO

Roadway at old elevation; sidewalks and manholes at new elevation

Fig. 3 is a view of the same work looking south. The sidewalks are at the new elevation, that on the left being





FIGS. 2 AND 3. BUILDING A 12-FT. SEWER AND CHANGING THE GRADE OF CANAL ST., CHICAGO, FOR NEW UNION STATION

of plank and supported temporarily and that on the right being permanently located on top of the utility gallery. The shelter over the sidewalk at the right is at a new and temporary baggage-delivery platform, with elevators in the sidewalk.

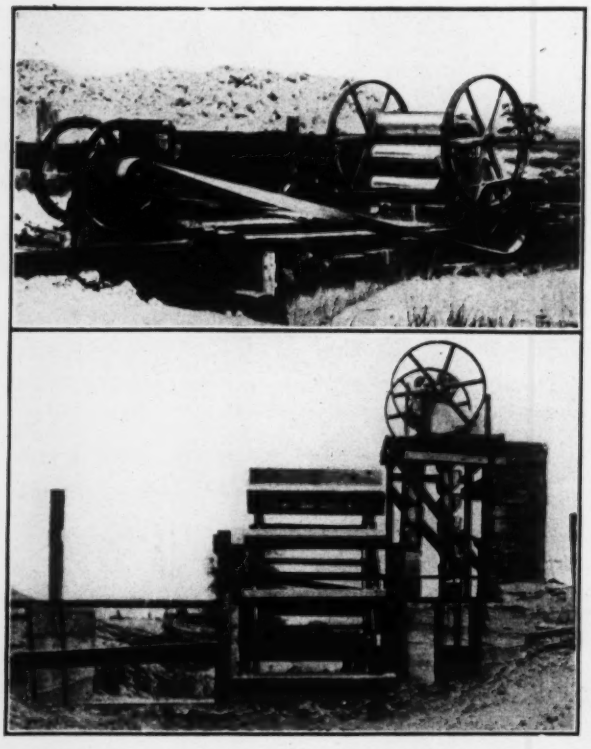
The street has now been filled to the new elevation at this point, with paved inclines in both directions to the old elevation, so as to facilitate the handling of baggage wagons during the construction of the station.

On the extreme left are the boom and dipper handle of the stream shovel, and between these and the backfilling the sewer is in various stages of construction. Along the concrete boundary wall are some of the telescopic chutes for concreting.

The sewer and utility gallery were built by the W. J. Newman Co., Chicago. The work was done according to the city's plans, but will be paid for by the Chicago Union Station Co., as it was necessitated by the construction of the station. Thomas Rodd, Pittsburgh, Penn. (Chief Engineer of the Pennsylvania Lines), is Chief Engineer of the company; A. J. Hammond, Chicago, is Assistant Engineer in direct charge of the work.

Chain-and-Bucket Lift for Irrigation Water

Water lifts of the chain-and-bucket type are used to a considerable extent in Western irrigation. About 800 such lifts, under the name "Famous Water Elevator," have been installed in the last few years by a Denver manufacturer. These lifts, shown in the accompanying illustrations, are made with galvanized-iron buckets, ball and roller bearings, and friction drive, in sizes of 250 to 1,000 gal. per min. capacity (requiring wells 4 ft. to 7 ft. in diameter). They have been made to operate with lifts as high as 135 ft. In one plant now in operation a 20-hp. gasoline engine, in the arid side of Colorado, raises 600 gal. per min. 135 ft.



FIGS. 1 AND 2. CHAIN-AND-BUCKET WATER ELEVATOR

Fig. 1 (Upper View)—Engine-driven unit on irrigation project. Fig. 2 (Lower View)—Elevator driven by home-made waterwheel

Fig. 2 shows an interesting installation for raising water out of the low-level main canal into higher-level laterals. The power is a home-made undershot waterwheel at a small drop in the main canal. This device raises 450 gal. per min. to a 12-ft. elevation. Windmill drives also have been used to some extent.

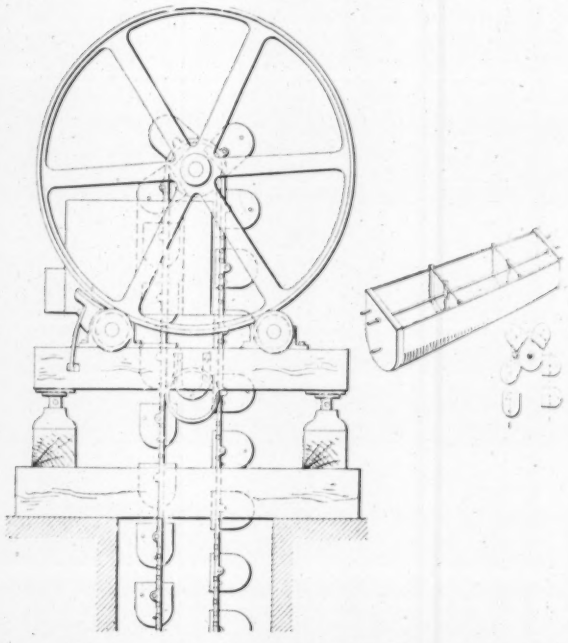


FIG. 3. DETAILS OF COLE WATER ELEVATOR

This machine has not been exploited for drainage pumping and contractors' use, although débris has been handled without serious trouble. The elevator is light and easily taken apart for transportation.

The device was developed by Henry Cole and certain features are patented. It is made by the Famous Water Elevator Co., Denver (A. J. Cole, General Manager).

Lining Ditches with Cement Gun

On many Hawaiian sugar plantations where irrigation is a necessity the soil conditions are such as to require lining of ditches. In this work much experimenting has been done with various kinds of plaster and cement linings, among the latter being gunite, or cement mortar applied with the cement gun. In a report to the Hawaiian Sugar Planters' Association, A. W. Collins, engineer of the Maui Agriculture Co., gives some data on the cement gun for such service.

The ditches are first roughly trimmed and ordinary chicken wire then fastened to the sides and bottom with nails or staples. Where the surface is uneven, it is brought to plane by mudding. On this wired surface a thin coat of mortar is applied with the cement gun.

A specific case of such work is described by Mr. Collins as follows:

We have finished 2½ mi. of open ditch and three short tunnels, their respective lengths being 250, 400 and 750 ft. The outfit has been entirely satisfactory, and very good results

have been obtained. On our larger ditch we have averaged about 100 ft. per day, a running foot being equivalent to 18 sq.ft. All the labor on the job has been under contract, varying on this larger ditch from 15 to 20c. per lin.ft. This cost covers mudding where the section is uneven, wiring, man for nozzle, men mixing sand and cement and supplying the gun, a helper for the engine and all labor for moving the outfit.

The tunnel work has given us a good line on what is possible with the gun. In all three tunnels the engine and gun have been at least 100 ft. from the end of the tunnel. This in the long tunnel would make an 850-ft. delivery pipe or hose from the gun to the nozzle. Working at this distance, however, diminishes the output considerably, since the air motor cannot be run wide open, as when working nearer. This means less material delivered to the discharge pipe and consequently less work.

The following is the record of complete cost of work for a period of five weeks on a ditch of 18 sq.ft. of surface:

Labor, 2,600 lin.ft. at 15c.	$390.00
Cement, 270 bbl. at $3.50	1,295.00
Sand	100.00
Gasoline, 870 gal. at 22c.	191.40
Wire mesh, 5,200 ft. (6 ft.) at 4c.	208.00
Wire mesh, 2,600 ft. (4 ft.) at 3c.	78.00
Superintendence	150.00
Incidentals	100.00
Cost of 2,600 lin.ft. = 46,800 sq.ft.	$2,512.40

New Idea in Windows

A novel scheme in metal-window construction is to be noticed in the equipment being installed in the new Frick Building at Pittsburgh. The new window cannot be called double-hung, casement, pivot or balanced. It is a distinct departure from all previous designs.

The window is framed of special rolled-steel sections, as shown in Fig. 2, and is divided vertically into two equal parts. The halves are hinged vertically, and each half is supported at top and bottom by a swinging arm pivoted on a stiff vertical center bar. A single hinged handle on one of the leaves enables a person to adjust the window to any open position, and this handle hooks over a catch on the center bar to lock closed. There is a simple notched plate on the sill frame swinging over to engage the corner of one leaf and to hold the window in any position. There are no loaded sliding parts except the hinges, and the window is easily operated.

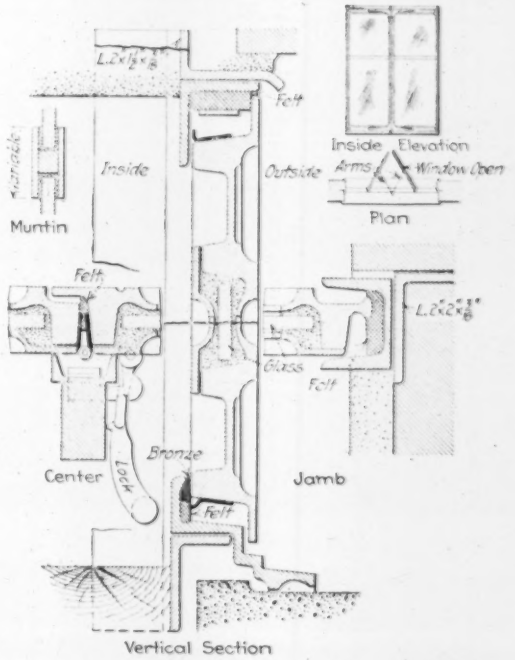


FIG. 2. DETAILS OF THE BROWNE WINDOW

FIG. 1. A NEW IDEA IN WINDOWS

The advantages in securing maximum light and air and the ease of cleaning both sides of the glass are apparent. By the general use of heavy felt packing strips and care in shaping the rolled-steel sections the window has been made highly weatherproof.

A sample window is reported to have successfully passed the fire-and-water test of the Underwriters' Laboratories. Various wind, rain and dust tests have been made—notably in the Woolworth Building tower in New York City and by the architects of the New York Telephone Co.—and the reported results are superior to those secured with familiar designs. This window is the invention of R. B. Browne, of Richey, Browne & Donald, Inc., ornamental metal workers, Maspeth, L. I.

NOTES

A Ballasted Track on a Paved Viaduct is an emergency arrangement employed by the Des Moines City Ry. for crossing the Seventh St. viaduct at Des Moines, Iowa. It is a reinforced-concrete structure with brick paving between the curbs, but the concrete floor was built with slots, or recesses, for tracks to be laid in future. The South Des Moines cars crossed an old wooden bridge at First St., but this was carried away by the ice in February. To reopen communication, a single track was laid over the Seventh St. viaduct, being placed at one side of the roadway, with ballast just clear of the gutter. The cinder ballast, retained by plank curbs, carries a track construction of ties and T-rails. It is intended to lay the permanent double-track line over the viaduct this year. This is part of extensive improvements con-